Pole Systems Engineering

IS8
Modeling
« Enterprise » System
in Systems Engineering

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The Society and Enterprises changes …

Hand Turkeys – The Missing Link in Mass Customization
by Joseph Flaherty

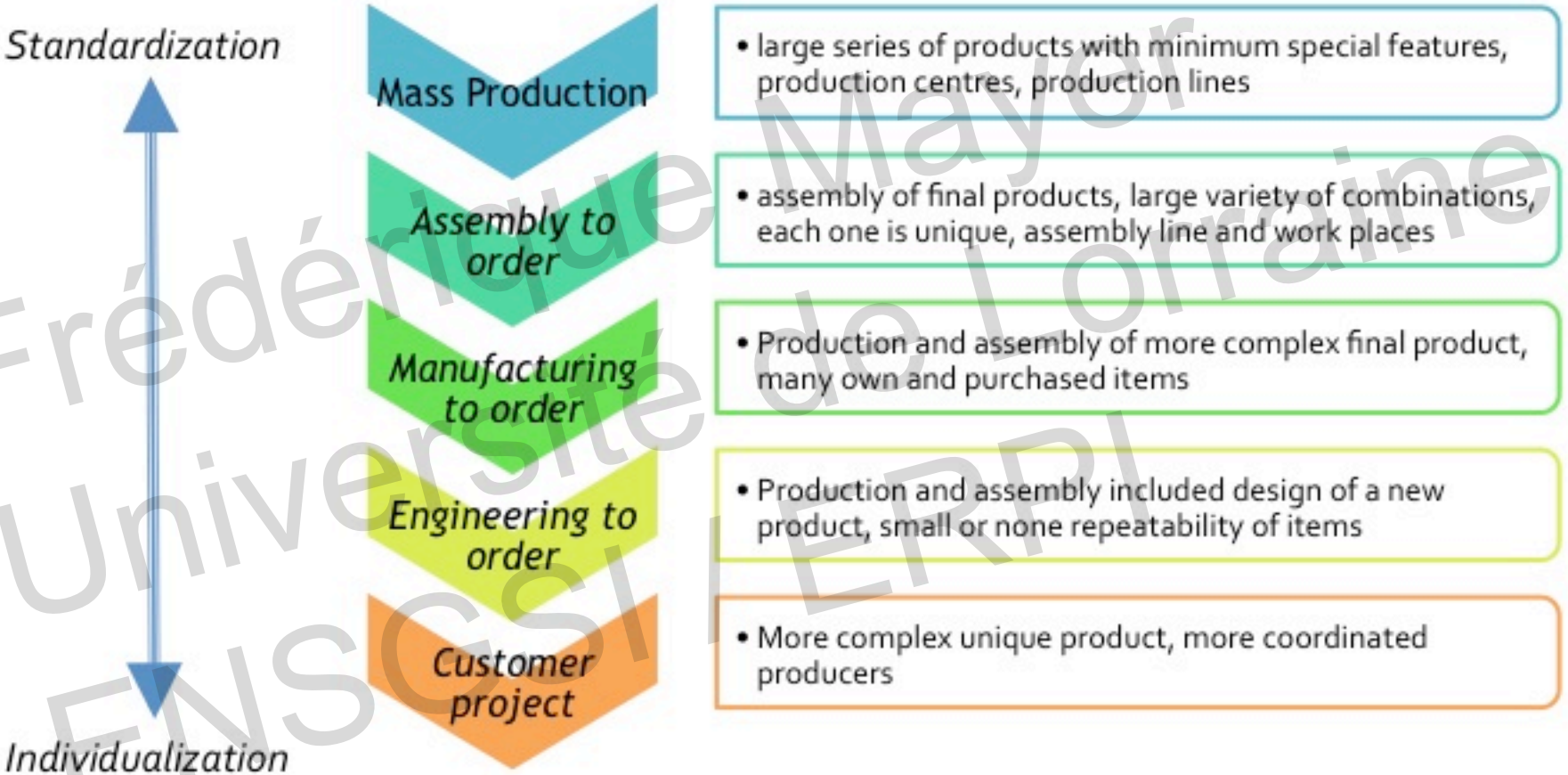
Manufacturing Customization

- *Strategies to co-create value between companies and customers*

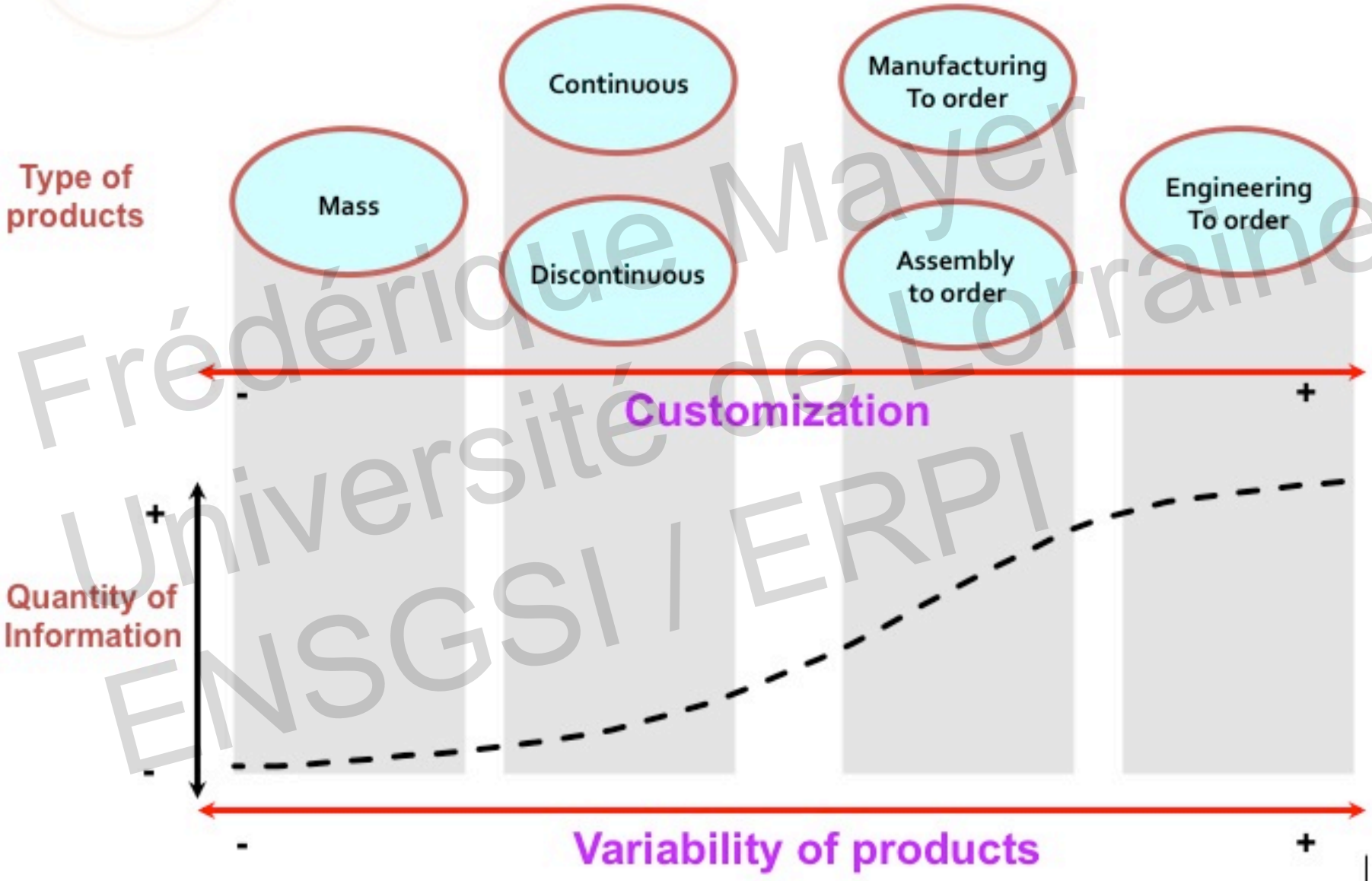
On demand Manufacturing and Business

- *Strategies to implement, on demand, business process with manufacturing practices in a globally open IT environment*

... As a consequence, organization's enterprise at issue ...



... to the reality of complexity : to manage information in a globally open IT environment ...



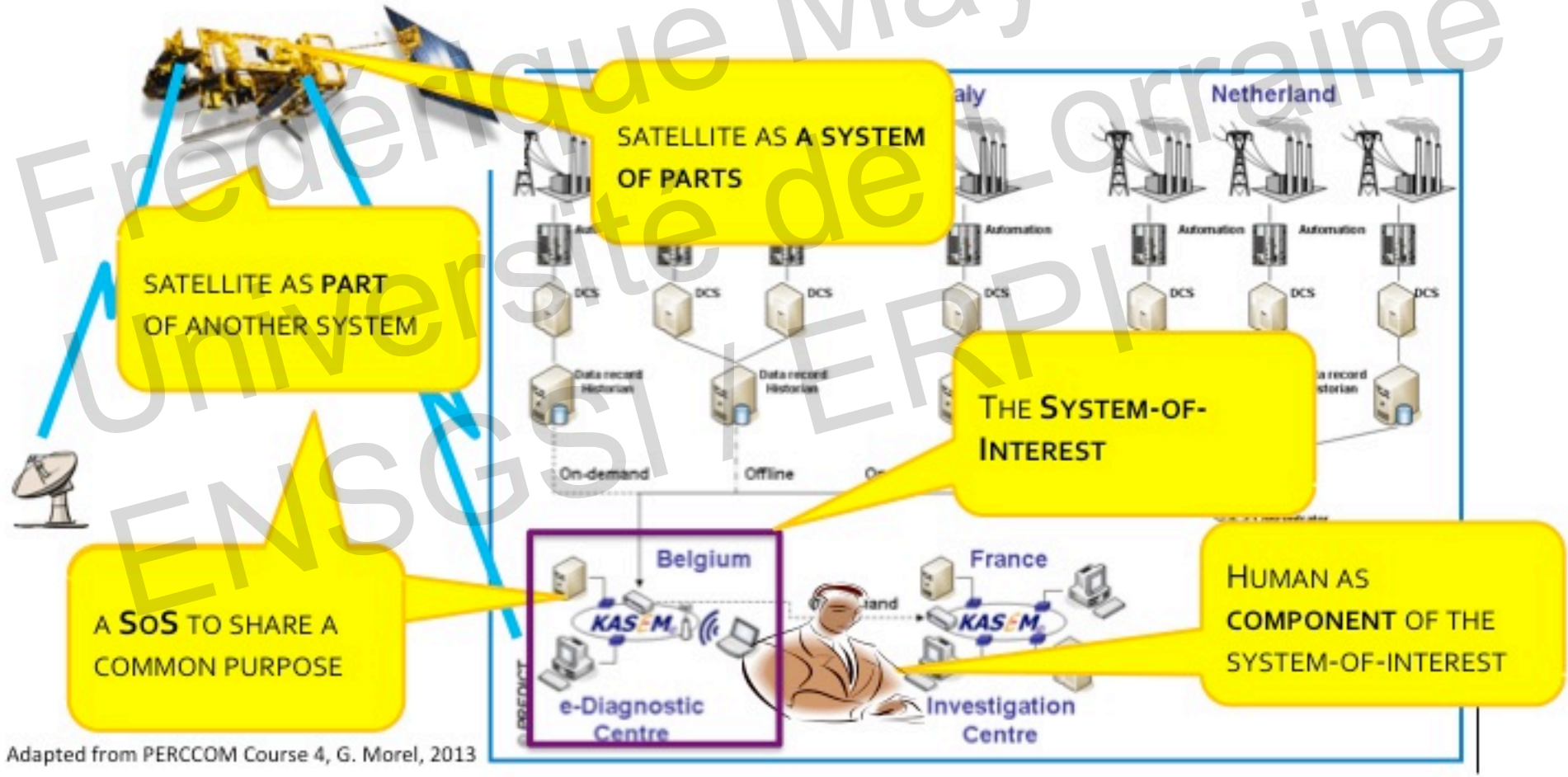
.. For the merge of IT based enterprises architectures … for new B&M&C&S process

ENGINEERING AN ENTERPRISE AS A WHOLE SYSTEM

Adapted from SAGE X3 training – AIP Nantes Novembre 2010

The process of engineering a (industrial, services, socio-technical) system changes ...

- Paradigms of Engineering is defined for any system that must be engineered as a WHOLE :
  - TOTALITY : with an holistic view : any system is composed of parts and is a part of another system
  - GLOBALITY : with a system based view : any system interacts with others systems, which it influences and which influence it. The system is OPEN.



Adapted from PERCCOM Course 4, G. Morel, 2013

… As a consequence, eight functional properties MUST BE satisfied when engineering a (industrial, services, socio-technical) system as a WHOLE

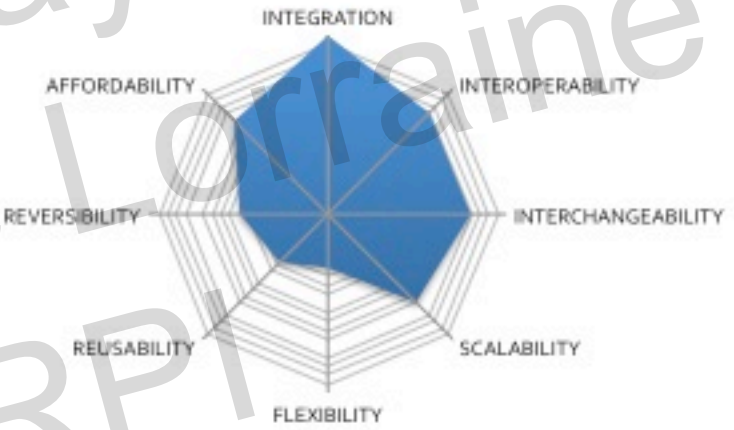
- A WHOLE (TOTALITY and GLOBALITY) open system is characterized by :

– The first property is **INTEGRATION**. This is the essential condition for an OPEN system to be a system. That it is fully or coupled or loosely , it characterizes the affiliation of elements to the same system and their support at the mission of the system.

– The feature most commonly associated with 'opening' is **INTEROPERABILITY**. This is the ability of the system to interact and work (interoperate) with others system.

– Then **INTERCHANGEABILITY** which is the ability of a hardware or software component to be replaced, without modification to the related interconnected components, by another one satisfying the same requirements.

– **SCALABILITY** is its ability to respond to changes in operation needs, both related to technology or capability by adding or replacing components.



… As a consequence, seven functional properties MUST BE satisfied when engineering a (industrial, services, socio-technical) system as a WHOLE

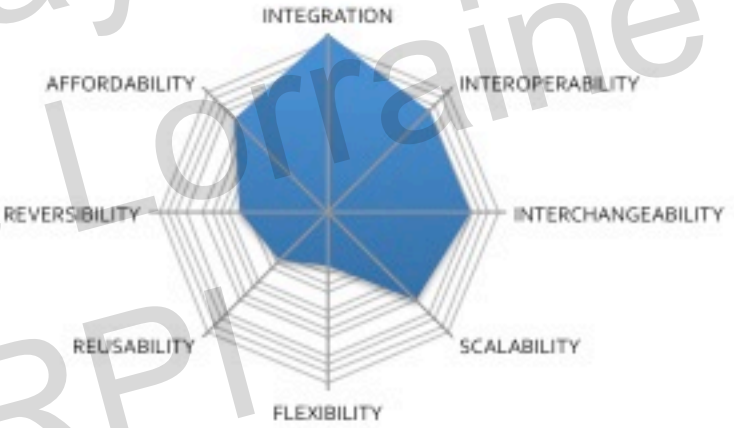
- A WHOLE (TOTALITY and GLOBALITY) open system is characterized by :

– **FLEXIBILITY** is the ability of the system to adapt to changes that may occur within its operating environment.

– **REUSABILITY** is the ability of a system or subsystem to be used without modification within a system of system or by another system which is different from the one it was originally developed.

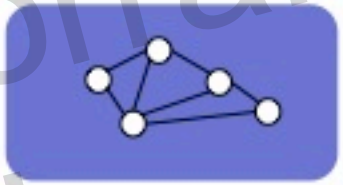
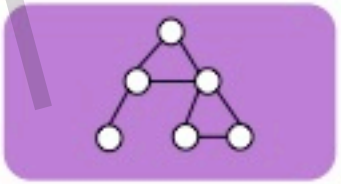
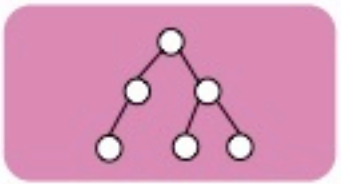
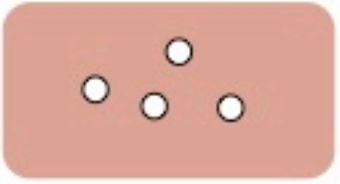
– **REVERSIBILITY** is the ability of a system, subsystem or component to be modified, updated by another manufacturer that whoever created it.

– And finally **AFFORDABILITY** that represents the ability of a system to satisfy operating performance at an acceptable use cost



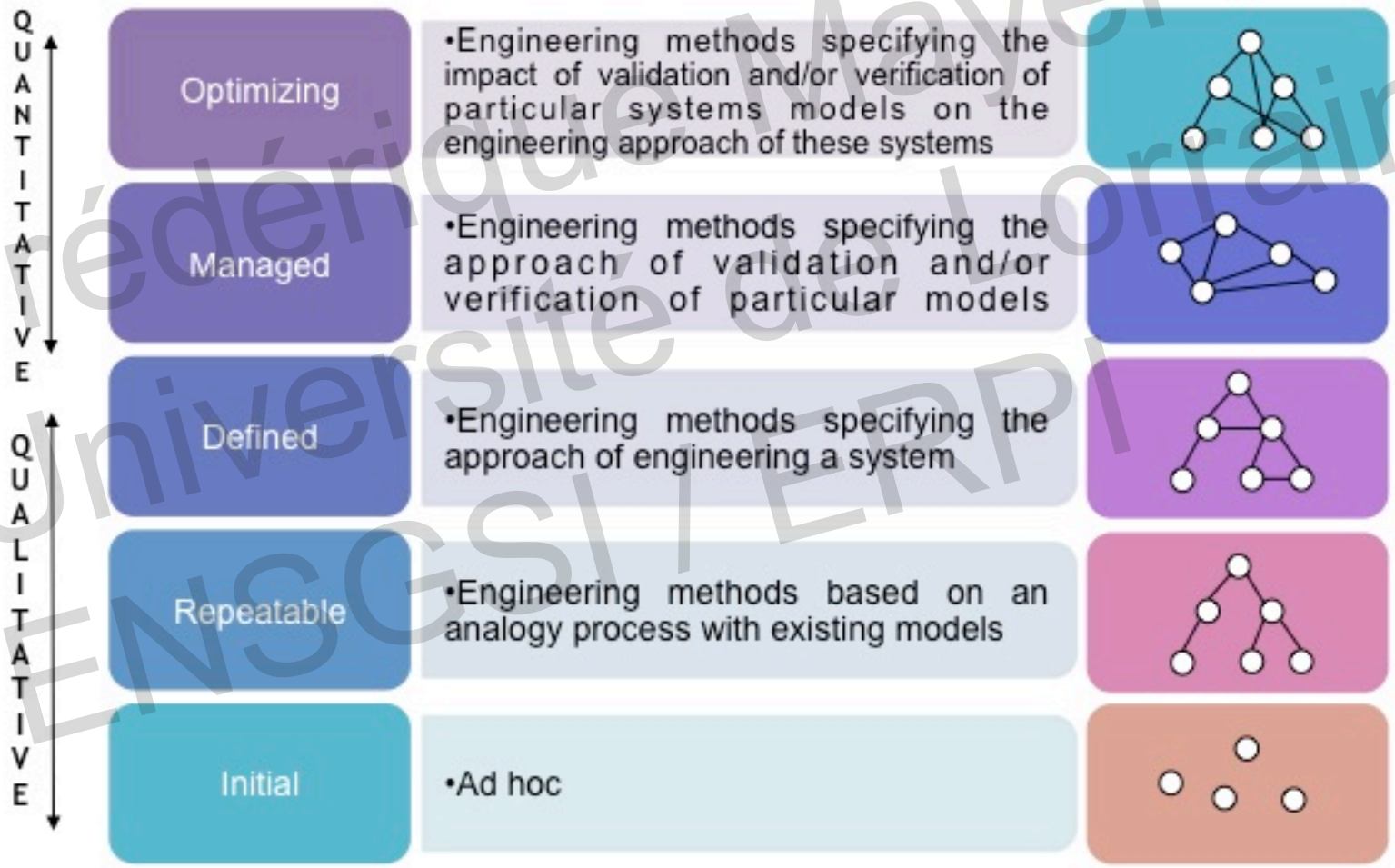
Metrics for an engineered enterprise as a WHOLE

- Process of verification & validation of architectures of enterprises (adapted from Hollocks, 97)

Adaptable	•Islands of automation able to organize themselves and to adapt them to their environment : MAS, HMS	
Interoperable	•Islands of automation able to cooperate by using services of each other : MES, IAM	
Defined	•Islands of automation able to inform them mutually and in interaction with their environment : CIM, CMMS	
Monolithic	•Coordinated Islands of automation : Hierarchical Systems	
Isolated	•Islands of automation working independently	

Metrics for an engineered enterprise as a WHOLE

- Process of verification & validation for engineering any enterprise as a WHOLE (adapted from Hollocks, 97)



… as a consequence, Terminology well defined …

- A good first step towards understanding is to provide key terms and their definition :

Pyster, A. and D.H. Olwell (eds). 2013. The Guide to the Systems Engineering Body of Knowledge (SEBoK), v. 1.1.2. Hoboken, NJ: The Trustees of the Stevens Institute of Technology. Accessed DATE., www.sebokwiki.org

The International Council on Systems Engineering (INCOSE) is a not-for-profit membership organization founded to develop and disseminate the interdisciplinary principles and practices that enable the realization of successful systems, www.incose.org

Faisandier, A. 2012. Engineering and Architecting Multidisciplinary Systems. Practical guidelines, Book series, sinergycom@mapsysteme.com (publisher), ISBN: 979–10–91699-00-6

The French affiliate chapter of the International Council on Systems Engineering. A not-forprofit membership organization to complete the INCOSE view with a French touch, www.afis.fr (in French)

Fiorèse, S. and Ménadier J.P. 2012. Découvrir et Comprendre l'Ingénierie Système. Cepadues Editions, www.arche.univ-lorraine.fr (in French)

Mayer, F. and Morel, G. 2013. Systems Engineering course 4. Erasmus Mundus PERCCOM Master documents. © Université de Lorraine

Hoffmann, H.P. 2010Systems Engineering Best practices with the Rational Workbench for Systems and Software Engineering. Deskbook.

… as a consequence, Terminology well defined …

- A good first step towards understanding is to provide key terms and their definition :
  - A system is "a set of elements and a set of inter-relationships between the elements such that they form a bounded whole relative to the elements around them" (Bertalanffy 1968) which exists in an environment which contains related systems and conditions. This definition encompasses most of those which are relevant to SE.
  - a system is an interacting combination of system elements to accomplish a defined objective(s). And the system itself interacts with its environment that may include other systems, users, and the natural environment.
  - The system elements that compose the system may include hardware, software, firmware, people, information, techniques, facilities, services, and other support elements
  - An engineered system, resulting of an engineering process, is an open system of technical or sociotechnical elements that exhibits emergent properties not exhibited by its individual elements :
    - It is created by and for people;
    - has a purpose, with multiple views;
    - satisfies key stakeholders' value propositions; has a life cycle and evolution dynamics;
    - has a boundary and an external environment;
    - and is part of a system-of-interest organization
  - A system of systems : two or more systems that are separately (managerial and operational independence) defined but operate together to perform a common goal. [CHE 99]

… to combine Systems Thinking & Practical Guidelines with intuition & Experiences : the Systems Engineering challenge !

• Systems Engineering to engineer a system as "more than the sum of its parts" remains a multidisciplinary subject area that started to develop in the last forty years and it has been the response to the many challenges associated with large, complex technological processes coming from multitechnology and life cycle issues :

– That's partly results of the dominant scientific approach to problem solving, based on the Cartesian paradigm enabling reductionism "to look inwards" into a system to locally optimise how it works, instead of enabling synthesis as Systemic paradigm to "look outwards" from a system to globally understand its interactions both with its environment and other systems.

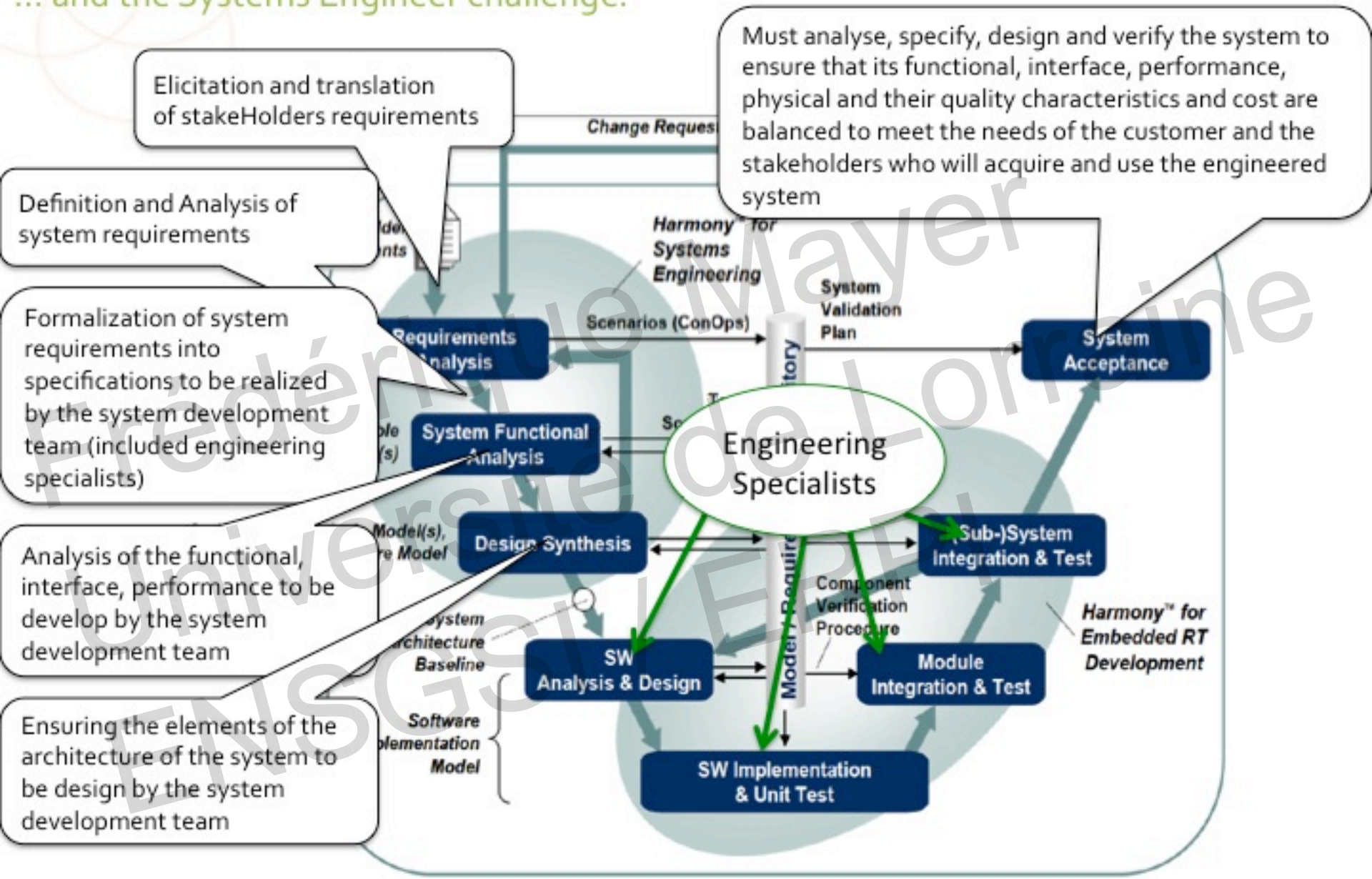
• Systems engineering is related to the application of systems science (principles, rules, laws) through a set of defined activities to answer complex practical problems or opportunities creating, arranging concepts and implementing them.

… to combine Systems Thinking & Practical Guidelines with intuition & Experiences : the Systems Engineering challenge !

• One way to understand the motivation behind systems engineering is to see it as a method, or practice, to identify and improve common rules that exist within a wide variety of systems. Keeping this in mind, the principles of Systems Engineering — holism, emergence, behavior, boundary, et al. — can be applied to any system, complex or otherwise, provided systems thinking is employed at all levels :

– That's also results of the pragmatic industrial approach to real life situations solving, based on Standardised Capability Maturity Models focusing on just in time efficient frameworks without rationally founding the correspondent emerging paradigms.

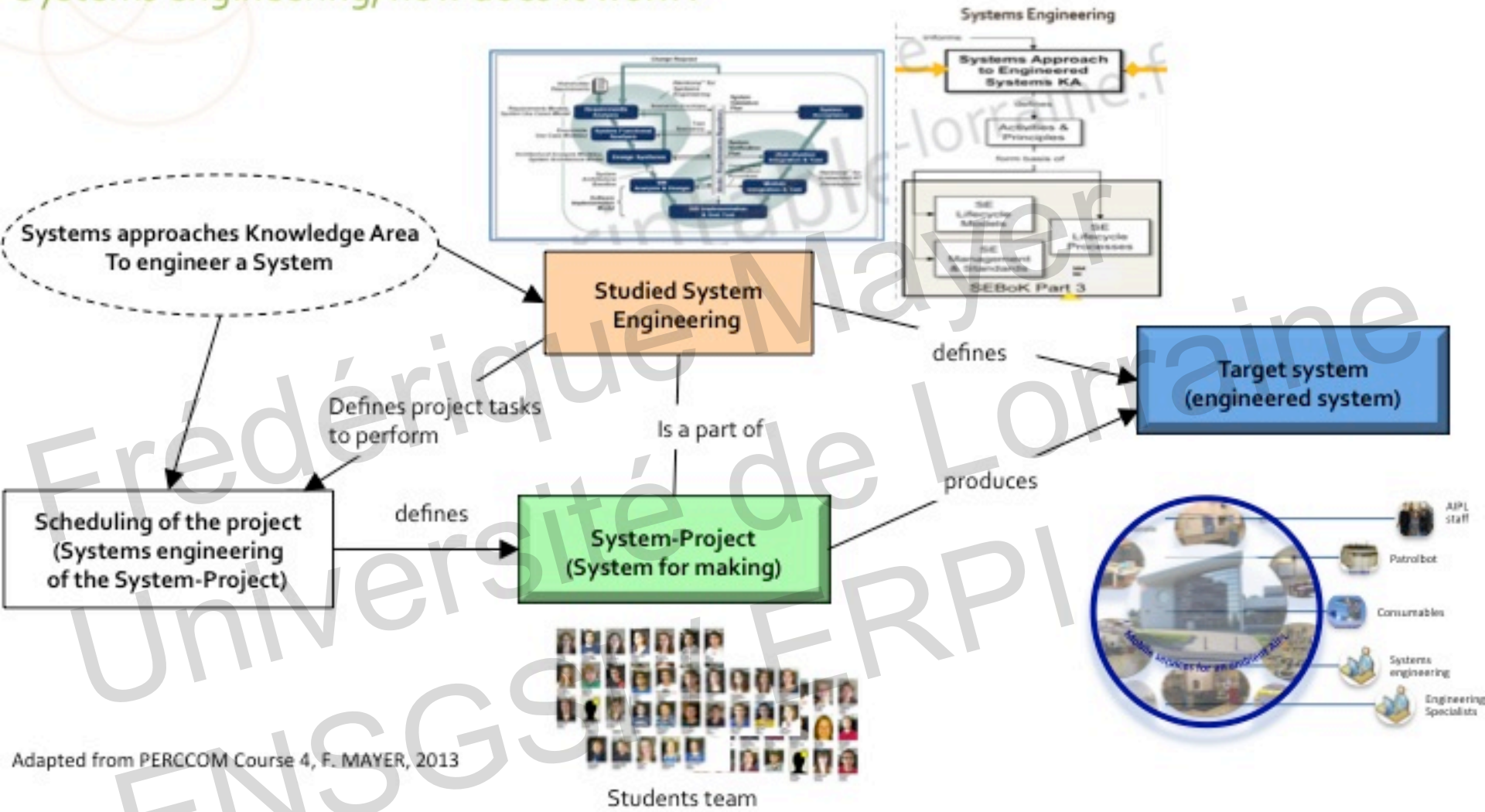
… and the Systems Engineer challenge.



… to combine Systems Thinking & Practical Guidelines with intuition & Experiences : the Systems Engineering challenge !

- Systems Engineering at a glance !
  - **The most important aspect may be the functional and operational needs analysis of the system to be designed, and the mission, objectives or purpose the system is designed for.**
    - **This involves a definition of the stakeholders and their involvement in the system design and operation.**
  - **After defining functional and operational needs, as well as the objective, or purpose of the system, the requirements to the system performance over its lifetime are specified.**
    - **The emerging conflicts in the requirements have to be sorted out by the stakeholders, or by some trade-off. This part of Systems Engineering is closely related to the general engineering design.**

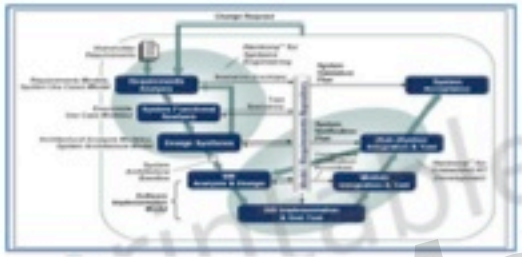
Systems engineering, how does it work ?

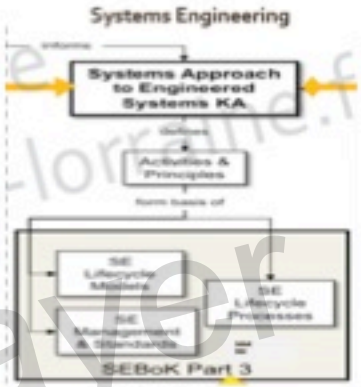


System-Project : combination of teams, methods, processes and means organized in order to meet the requirements of design, evolution and verification of the definition of the system to be made.

This "system for making" the system of interest is with organization as the dominant characteristic.

Systems engineering, how does it work ?





Systems approaches Knowledge Area To engineer a System

Studied System Engineering

defines

Target system (engineered system)

Defines project tasks to perform

Is a part of

produces

Scheduling of the project (Systems engineering of the System-Project)

defines

System-Project (System for making)

Students team

Adapted from PERCCOM Course 4, F. MAYER, 2013

Target System : combination of materials, software's, human competencies and processes organized in order to meet a need in accordance with requirements.

This **"System to be made"** by systems engineering is with technologies as the dominant characteristic.

… as a consequence, Terminology well defined …

- A good first step towards understanding is to provide key terms and their definition :

  – Project (by ISO 10006) : Unique process, consisting of a set of coordinated and controlled activities with start and finish dates, undertaken to achieve an objective conforming to specific requirements, including the constraints of time, cost and resources.

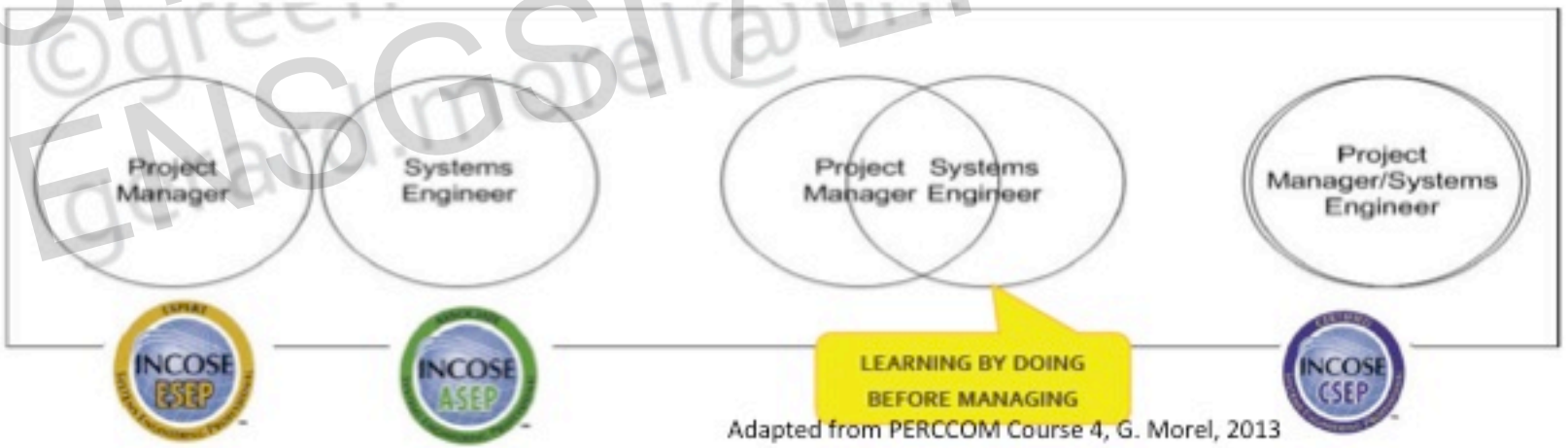
    - Note 1 : An individual project may form part of a larger project structure.
    - Note 2 : In some projects the objective(s) is refined and the product characteristics defined progressively as the project proceeds.
    - Note 3 : The outcome of a project may be one or several units of product.
    - Note 4 : The organization is temporary and established for the life time of the project
    - Note 5 : The interactions among project activities may be complex

… as a consequence, relationships between systems engineering & project management well defined …

- Depending on the environment and organization, the two disciplines can be disjoint, partially intersecting, or one can be seen as a subset of the other.

- While there is no standard relationship, the project manager and the systems engineer encompass the technical and managerial leadership of a project between them, which requires the enterprise of each project manager and system engineer to work out the particular details for their own context.

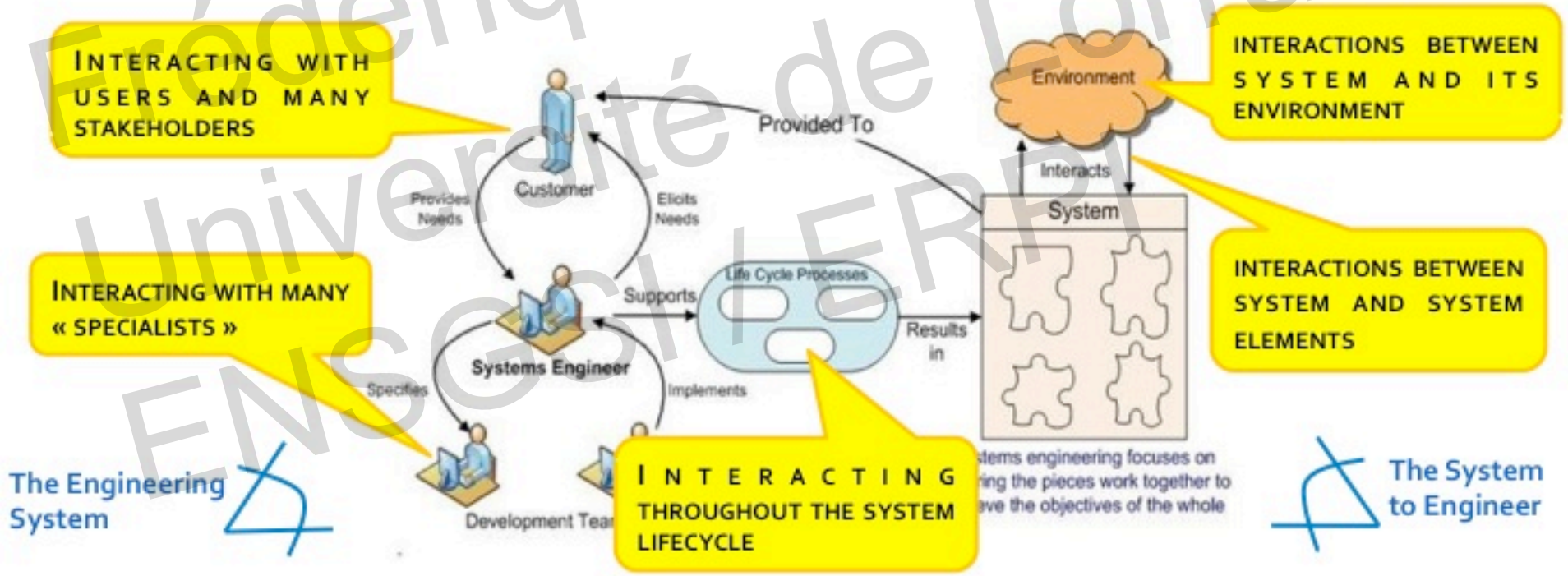
- INCOSE Systems Engineering Professional Certification :
  - Associate Systems Engineering Professionals (ASEP) : recently graduated or just starting to practice SE
  - Certified Systems Engineering Professionals (CSEP) : Minimum 5 years SE experience
  - Expert Systems Engineering Professionals (ESEP) : Minimum 20-25 years SE experience



Adapted from PERCCOM Course 4, G. Morel, 2013

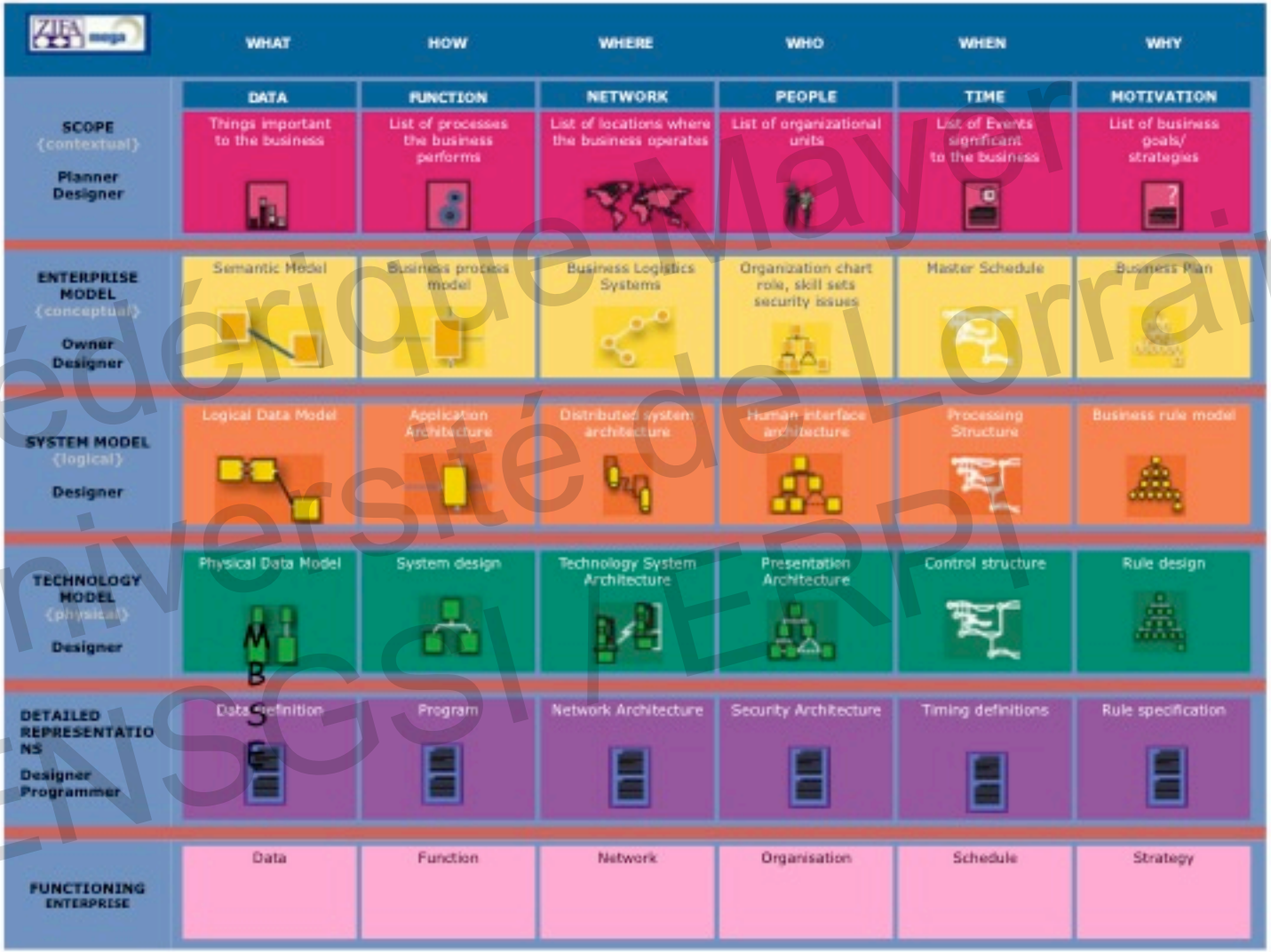
Engineering a "System" Enterprise as a WHOLE : Systems engineering key facts …

- Systems Engineering (SE) is an interdisciplinary approach and means to enable the realization of successful systems.
  - It focuses on holistically and concurrently understanding stakeholder needs; exploring opportunities; documenting requirements; and synthesizing, verifying, validating, and evolving solutions.
  - It considers the complete problem, from system concept exploration through system disposal.
  - Some key elements of systems engineering are described below in order to highlight that SE focuses mainly onto interactions in order to engineer a system as a whole.



Adapted from PERCCOM Course 4, G. Morel, 2013

… associated to a pragmatic industrial approach to real life situations solving : the analysis table ZACHMAN-SE

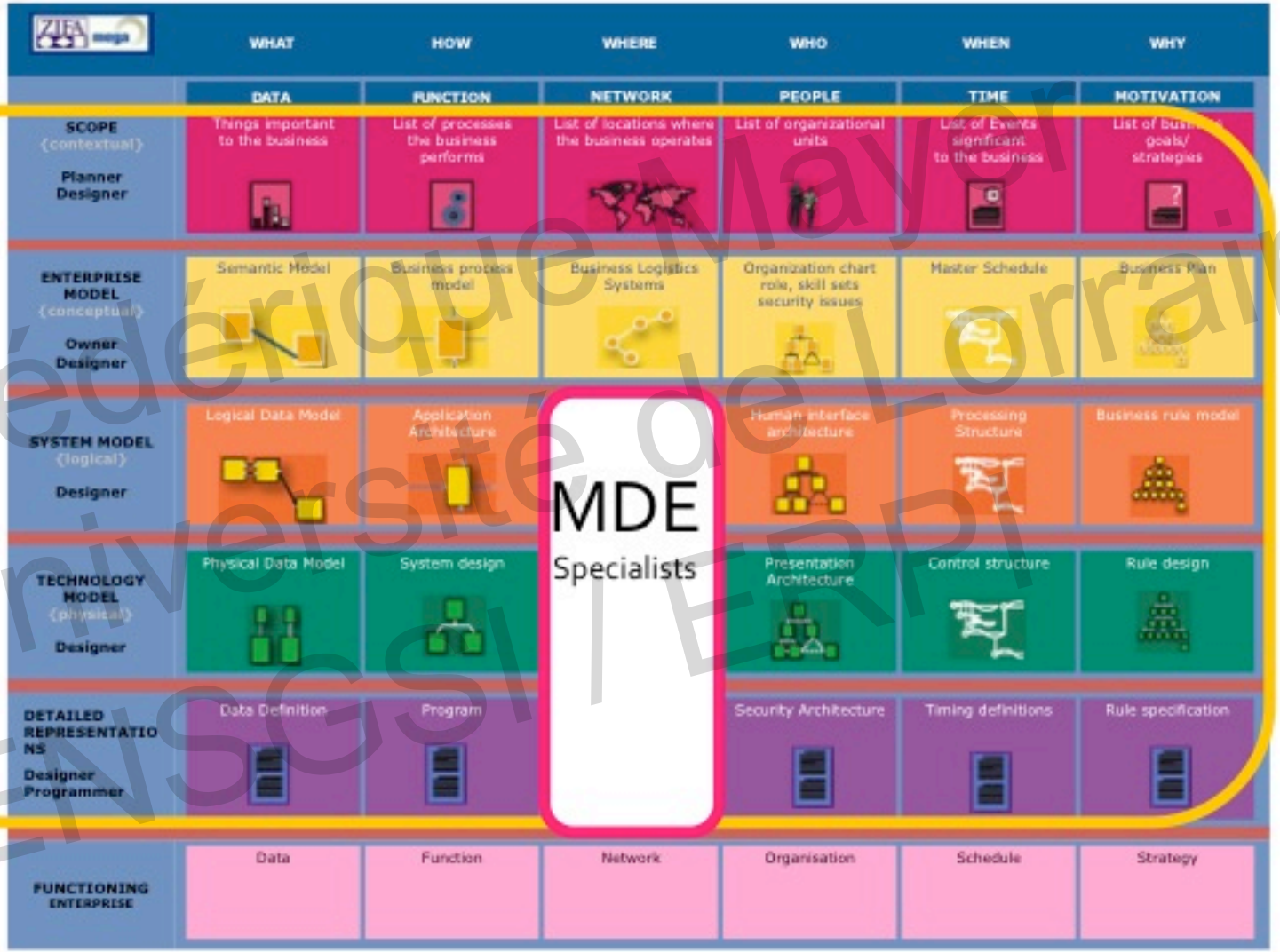


Motivation for ZACHMAN Framework !

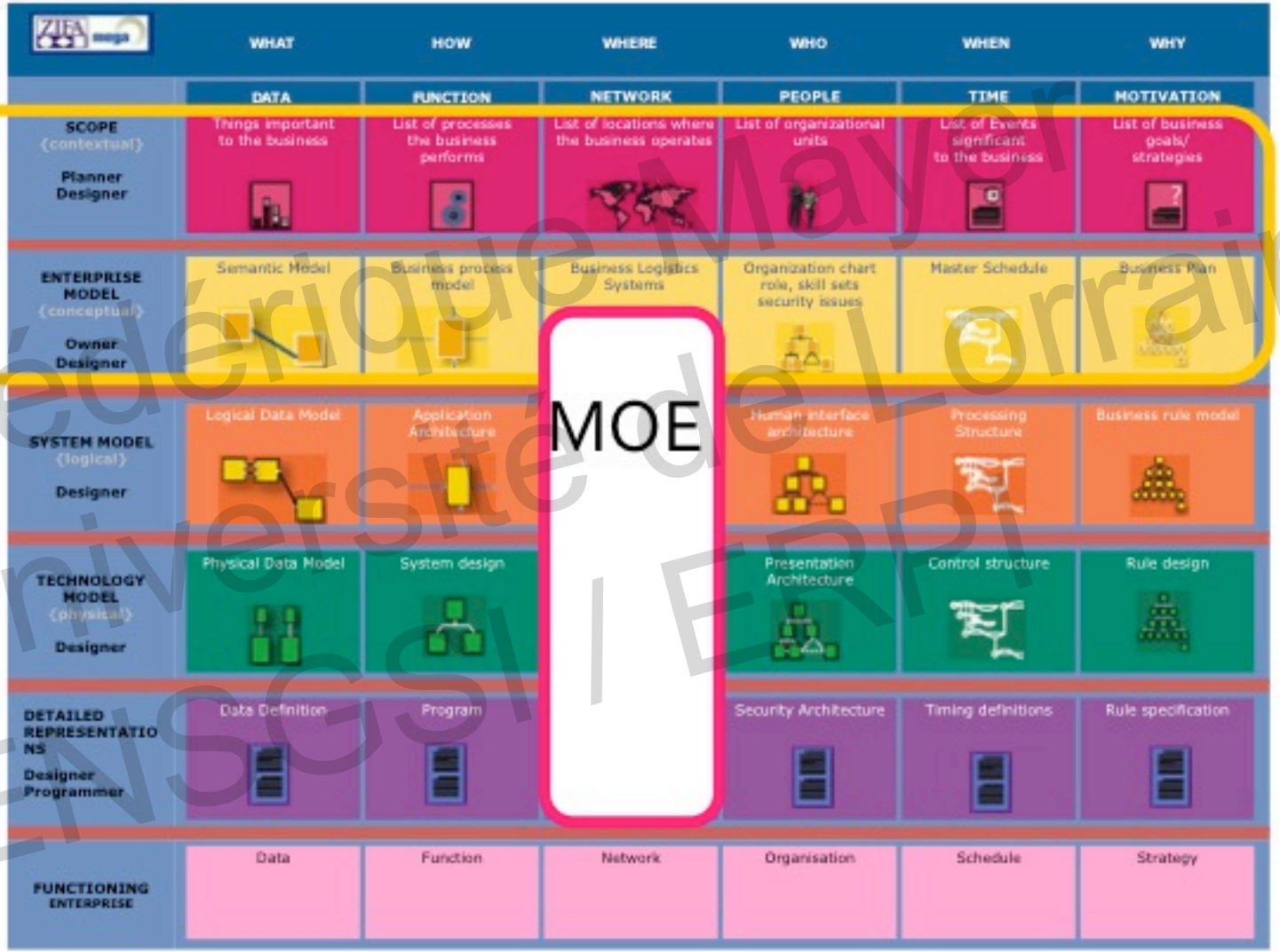
• The Zachman framework can successfully be used as a tool for defining project scope, for checking project completeness, and as a learning tool for enterprise architecture.

- Project scope definition: Most projects do not need to cover all enterprise analysis dimensions. The Zachman framework helps business analysts and system architects organize their thoughts about architecture and guides them to narrow the scope of the modeling artifacts required to carry out their projects. It is then easier to tackle the "where to start" question and to define a methodology path tailored to the project needs. For instance, rows in the framework identify types of stakeholders and the associated detail of information they require. Detailed SQL data types are not the right modeling artifact if the objectives is to build a map of core business objects.
- Checking project completeness: Another difficult question to answer is whether any significant element was left out of the project scope. The Zachman Framework ensures all appropriate aspects are addressed or used as a discussion support tool. For instance, geographical location issues might be crucial for the project and must be analyzed at all levels of the abstraction stack: business process, IT ystems, distributed objects.
- A learning tool: As enterprise architects get more familiar with enterprise modeling, they discover the benefits of having multiple dimensions for enterprise projects and how methodology steps can used to move from one cell to another. Model driven approach can be better enforced within project and increase their success factors.

Motivation for ZACHMAN Framework !



Motivation for ZACHMAN Framework !



The columns table analysis of ZACHMAN

• The columns in the Zachman framework represent different areas of interest for each perspective. The columns describe the dimensions of the systems definition and development effort.

WHAT	HOW	WHERE	WHO	WHEN	WHY

- WHAT (Data): Each of the rows in this column address understanding of and dealing with an enterprise's data. In this column, the objects of interest that concern the company and affect its direction and purpose.
- HOW (Function): The rows in the function column describe the process of translating the mission of the enterprise into successively more detailed definitions of its operations.
- WHERE (Network): This column is concerned with the geographical distribution of the enterprise's activities.
- WHO (People): The fourth column describes who is involved in the business and in the introduction of new technology.
- WHEN (Time): The fifth column describes the effects of time on the enterprise. It is difficult to describe or address this column in isolation from the others, especially column two.
- WHY (Motivation): this is concerned with the translation of business goals and strategies into specific ends and means. This can be expanded to include the entire set of constraints that apply to an enterprise's efforts.

The rows table analysis of ZACHMAN

- The rows represent various abstraction levels typically involved in the systems definition and development process:

  - Scope (Planer view): Definition of the enterprise's direction and business purpose. This is necessary to establish the context for any system development effort.

  - Model of the business (Owner's view): This defines — in business terms — the nature of the business, including its structure, functions, organization, and so forth.

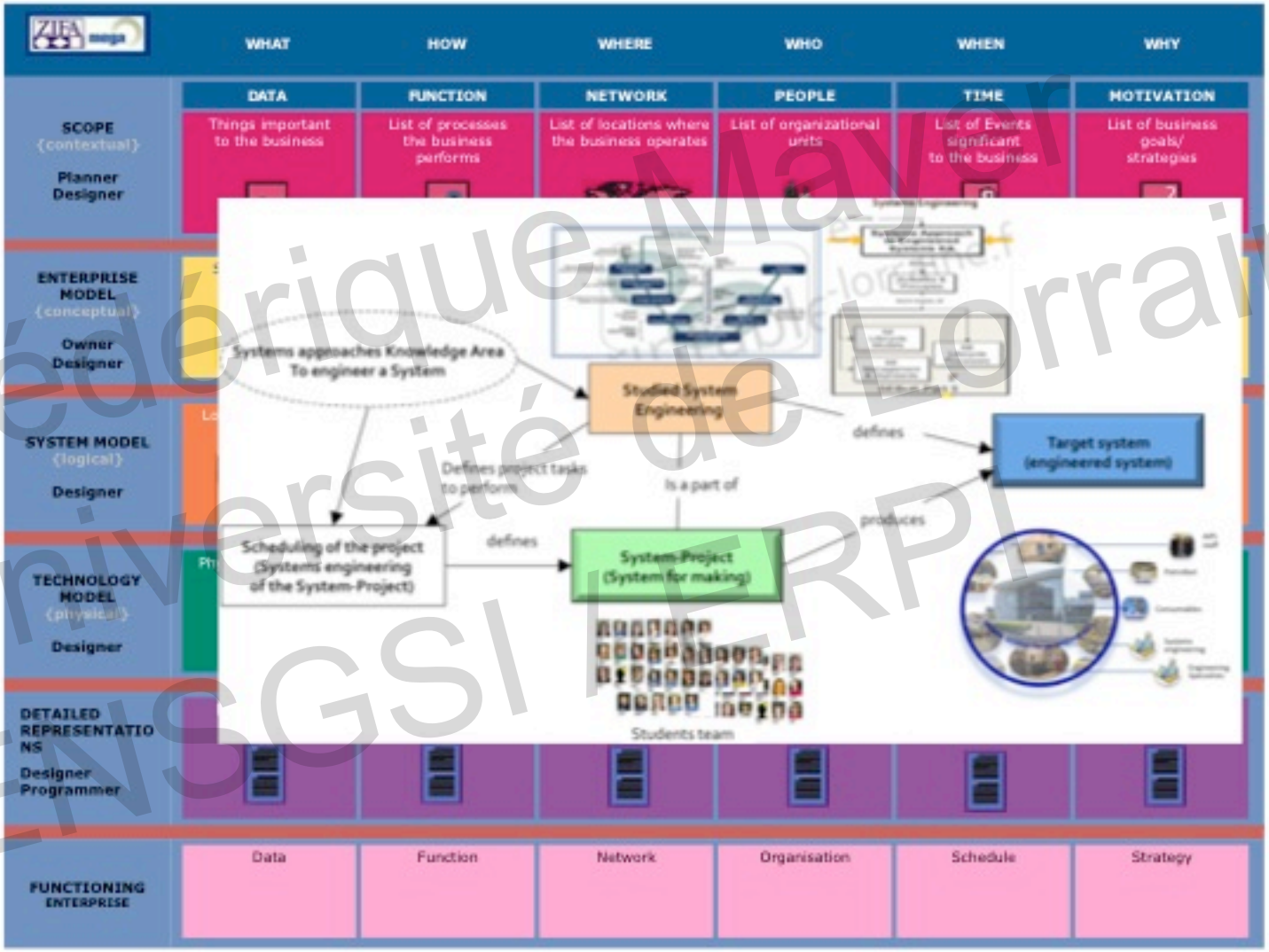
  - Model of the information system (Architect's view): This defines the business described in step 2, but in more rigorous information terms.

  - Technology model (Designer's view): This describes how technology may be used to address the information processing needs identified in the previous rows.

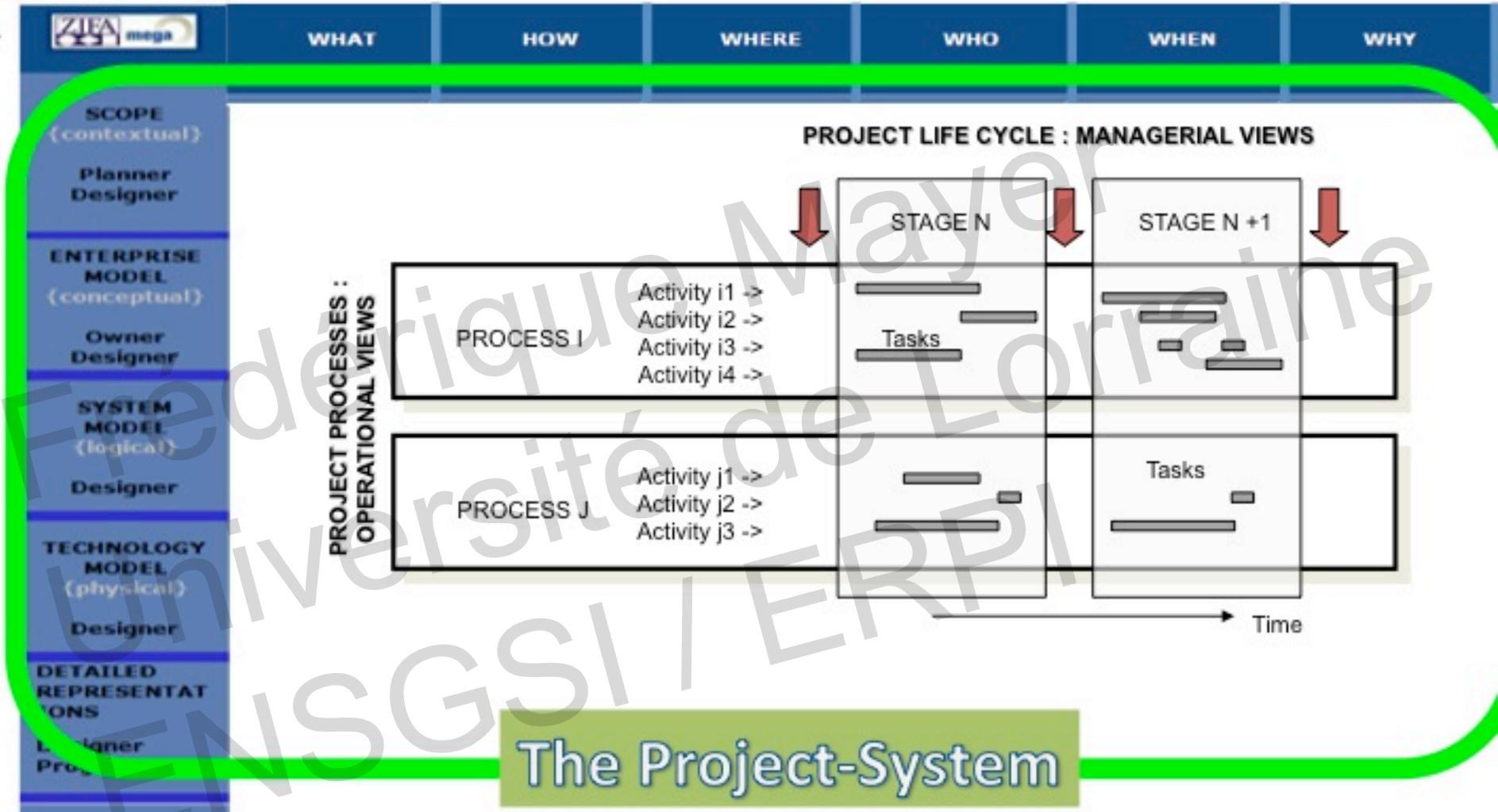
  - Detailed representations (Builder's view): Here a particular language is chosen, and the program listings, database specifications, networks, and so forth are all produced.

  - Functioning system: Finally, a system is implemented and made part of an organization.

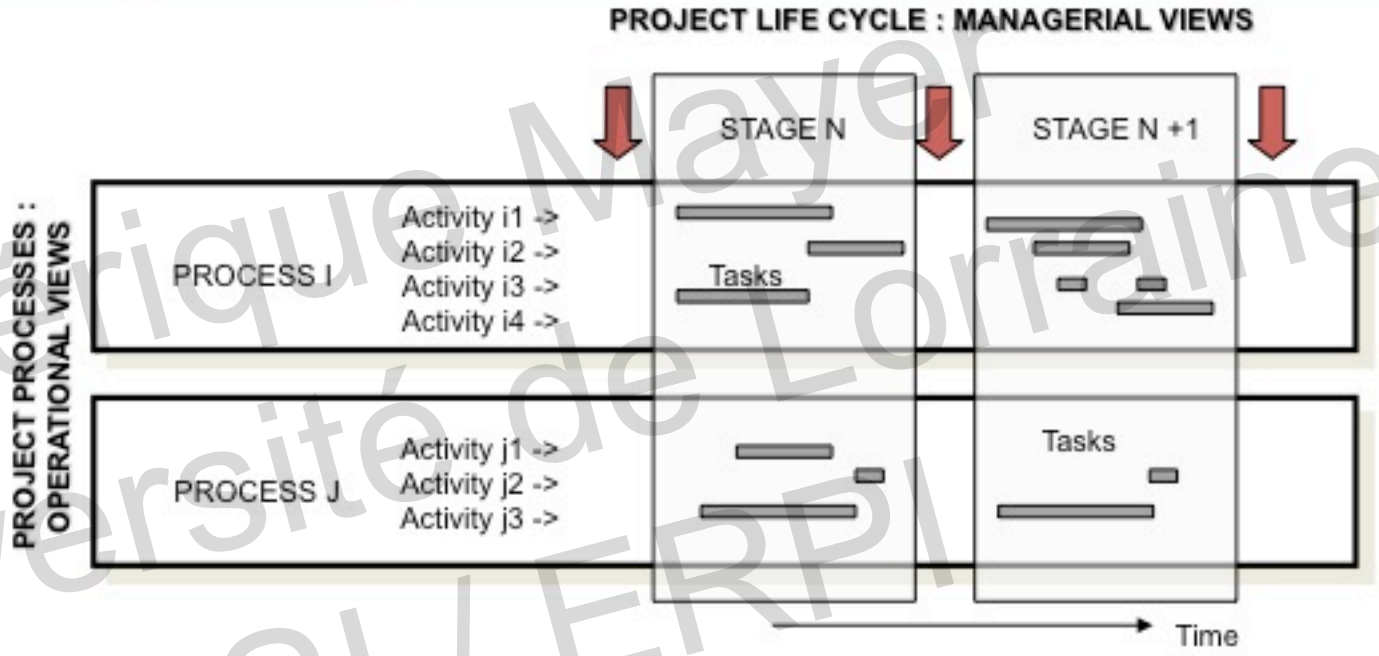
The pragmatic industrial approach to real life situations solving : the analysis table ZACHMAN-SE



The pragmatic industrial approach to real life situations solving : the analysis table ZACHMAN-SE

- 

	WHAT	HOW	WHERE	WHO	WHEN	WHY
SCOPE (contextual) Planner Designer						
ENTERPRISE MODEL (conceptual) Owner Designer						
SYSTEM MODEL (logical) Designer						
TECHNOLOGY MODEL (physical) Designer						
DETAILED REPRESENTATIONS Designer						
FUNCTIONING ENTERPRISE						



The operational Target System

Integration & Verification & Validation of the system model

- The key question in any modelling process, such as the Systems Engineering one, is to provide a model of a real system through a prescriptive approach based on **understanding of the modelled object**, and not only through a descriptive one applying a given framework to model an object (Wortmann, 1997).

- L'objet du processus de **Vérification** est de contrôler que les caractéristiques de conception de l'architecture sont satisfaites par le système. Ce processus fournit les informations requises pour effectuer les actions curatives qui corrigent les non-conformités du système concrétisé ou des processus qui agissent sur celui-ci.

  - Check compliance against specified requirements
  - **"Have you done the job right?"**

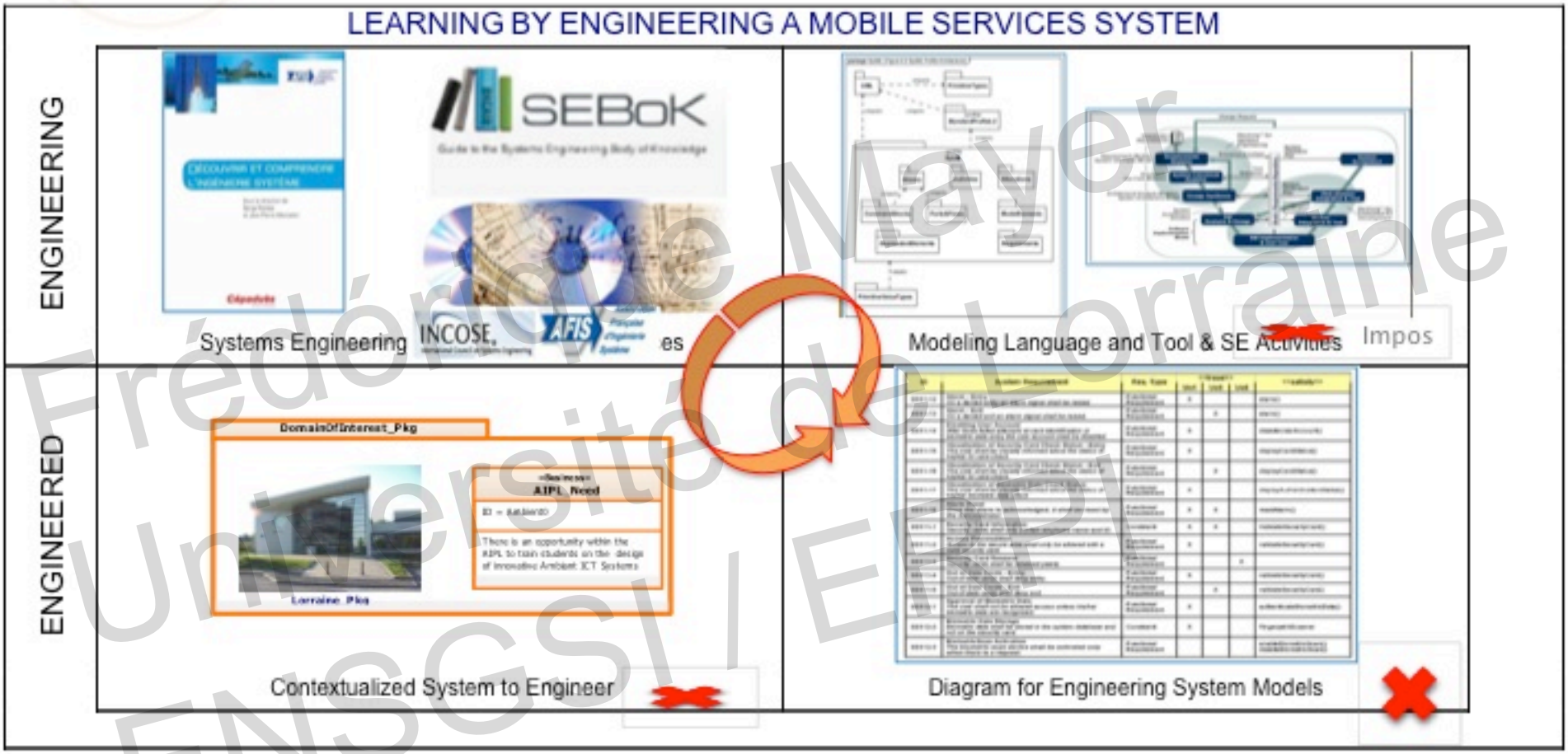
- L'objet du processus de **Validation** est de fournir des preuves objectives que les services fournis par le système en exploitation satisfont les exigences des parties prenantes. Ce processus réalise des comparaisons et contrôle que les exigences des parties prenantes sont correctement définies. Quand des écarts sont identifiés, ils sont enregistrés et donnent lieu à des actions correctives. La validation du système est avalisée par les parties prenantes.

  - Check satisfaction of stakeholders
  - **"Have you done the right job?"**

- Bonnes Pratiques=> construire à priori un Modèle correct à raffiner plutôt que de le corriger à postériori.

  - **Bien Faire** le Système
  - Faire le **Bon Système**

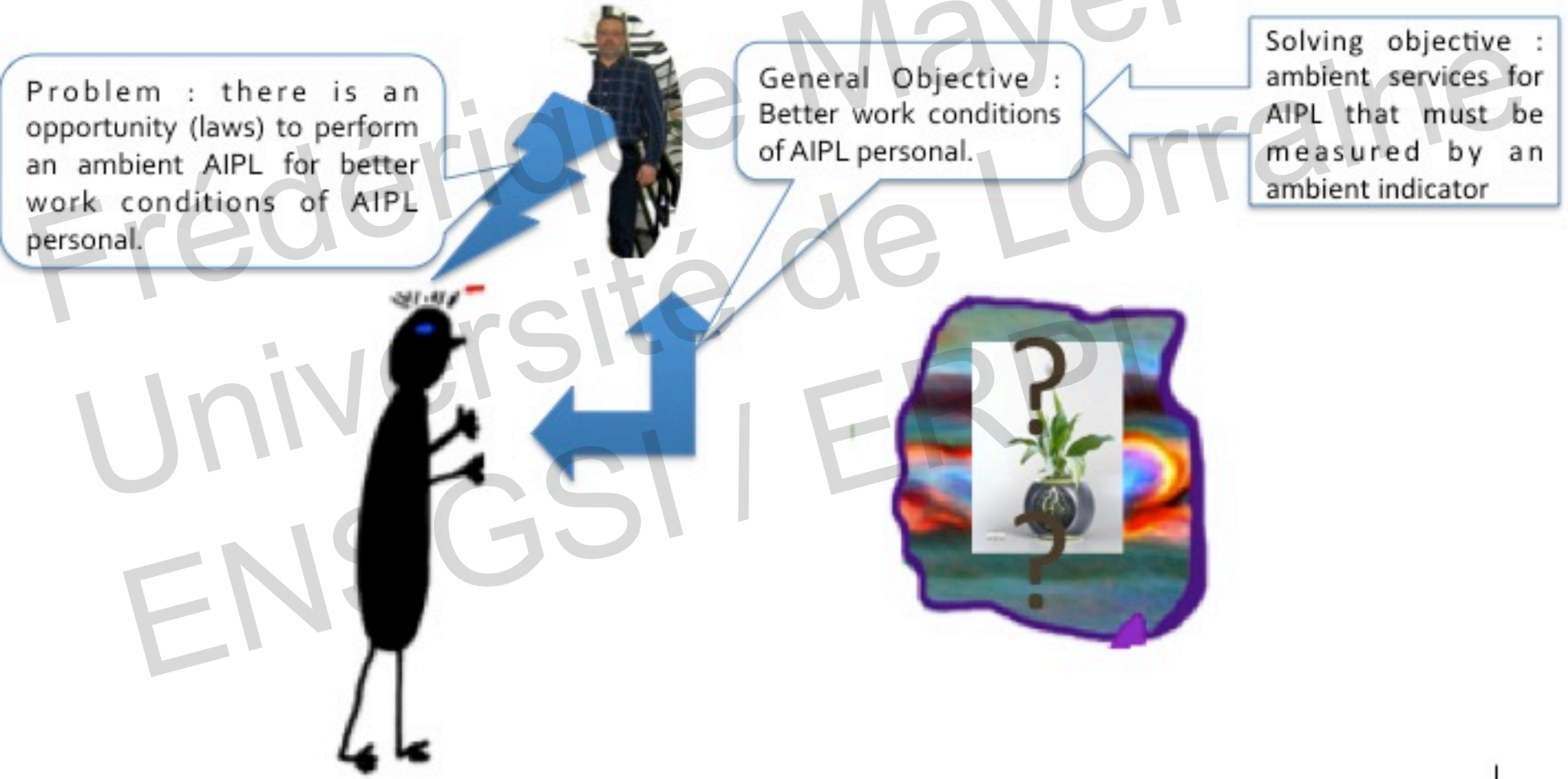
Now, dear Students, you have to do your job !



Adapted from PERCCOM Course 4, G. Morel, 2013

Systems engineering to perceive the reality of a System in order to right engineering!

- At the beginning of the story, nothing shows you that the phenomenon in front of you … is a system. It is an unknown phenomena. But the story of this phenomenon is a story to be very simply told.



Adapted from PERCCOM Course 4, F. MAYER, 2013

Learning by Engineering a Ambient IT-based System

Systems approaches Knowledge Area
To engineer a System

Studied System
Engineering

defines

Target system
(engineered system)

Defines project tasks
to perform

Is a part of

produces

Scheduling of the project
(Systems engineering
of the System-Project)

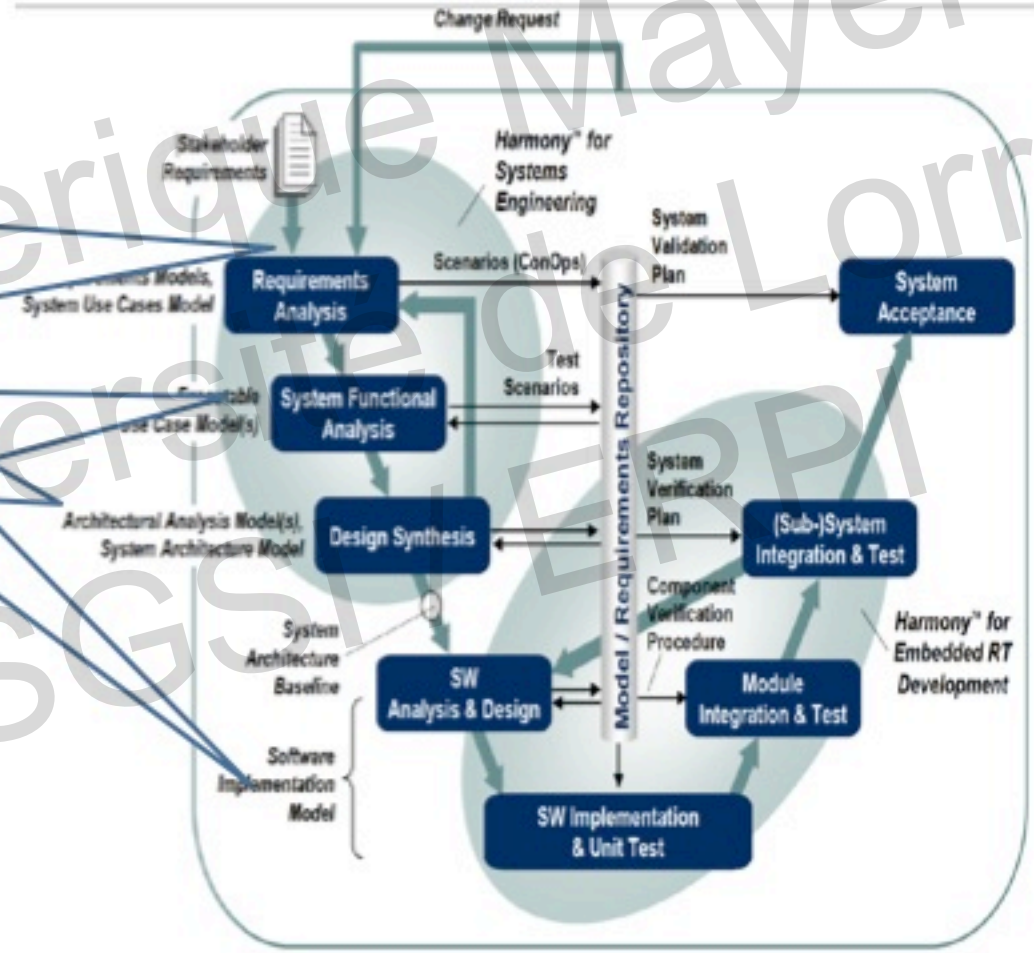
defines

System-Project
(System for making)

Model Based Systems Engineering (MBSE) to model the reality of a System in order to right engineering!

- DEFINITION of model based systems engineering (MBSE)
  - MBSE is defined as " the formalized application of modeling to support system requirements, design, analysis, verification, and validation activities beginning in the conceptual design phase and continuing throughout development and later life cycle phases."

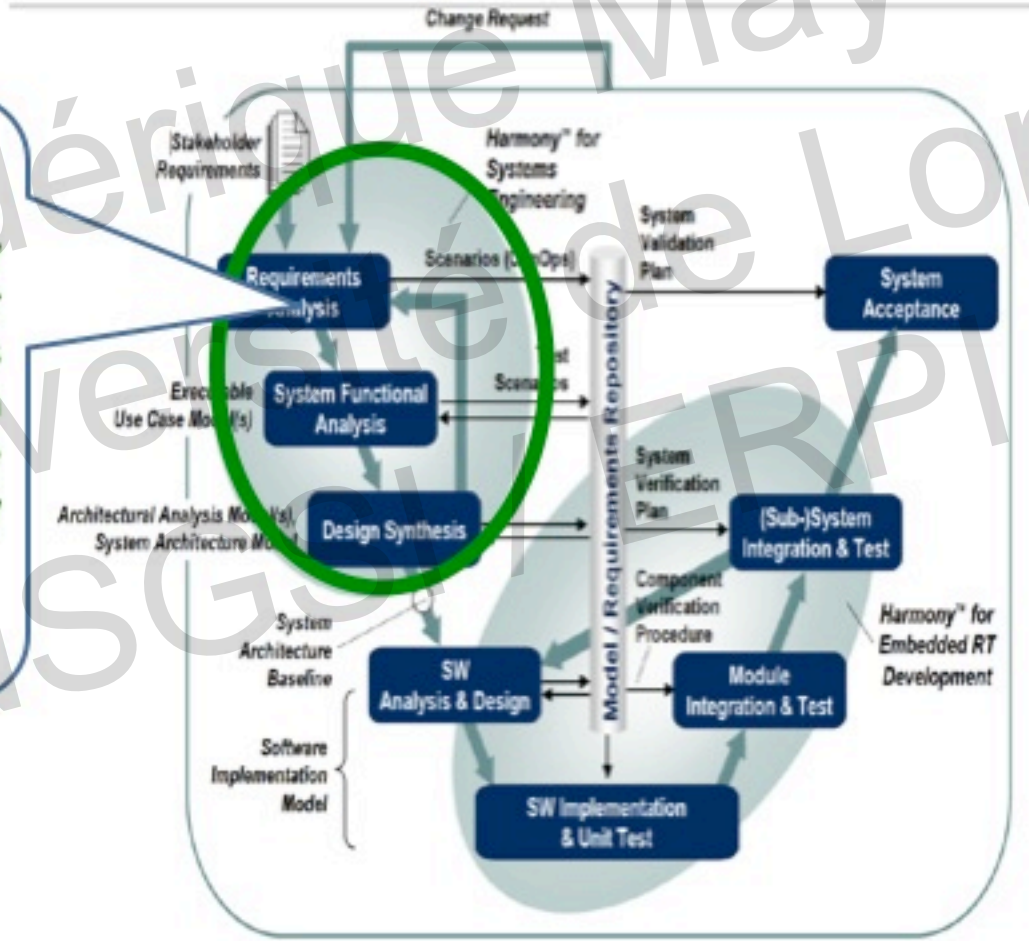
In MBSE, the models of the system are primary artifacts of the systems .



Model Based Systems Engineering (MBSE) to model the reality of a System in order to right engineering!

- Methods and Tools for model based systems engineering (MBSE)
  - A MBSE approach typically includes methods for model management which aim to ensure that models are properly controlled and methods for model validation which aim to ensure that models accurately represent the systems being modeled.

Rationale Harmony method for Systems Engineering with IBM Rational Rhapsody modeling tool.



Model Based Systems Engineering (MBSE) to model the reality of a System in order to right engineering!

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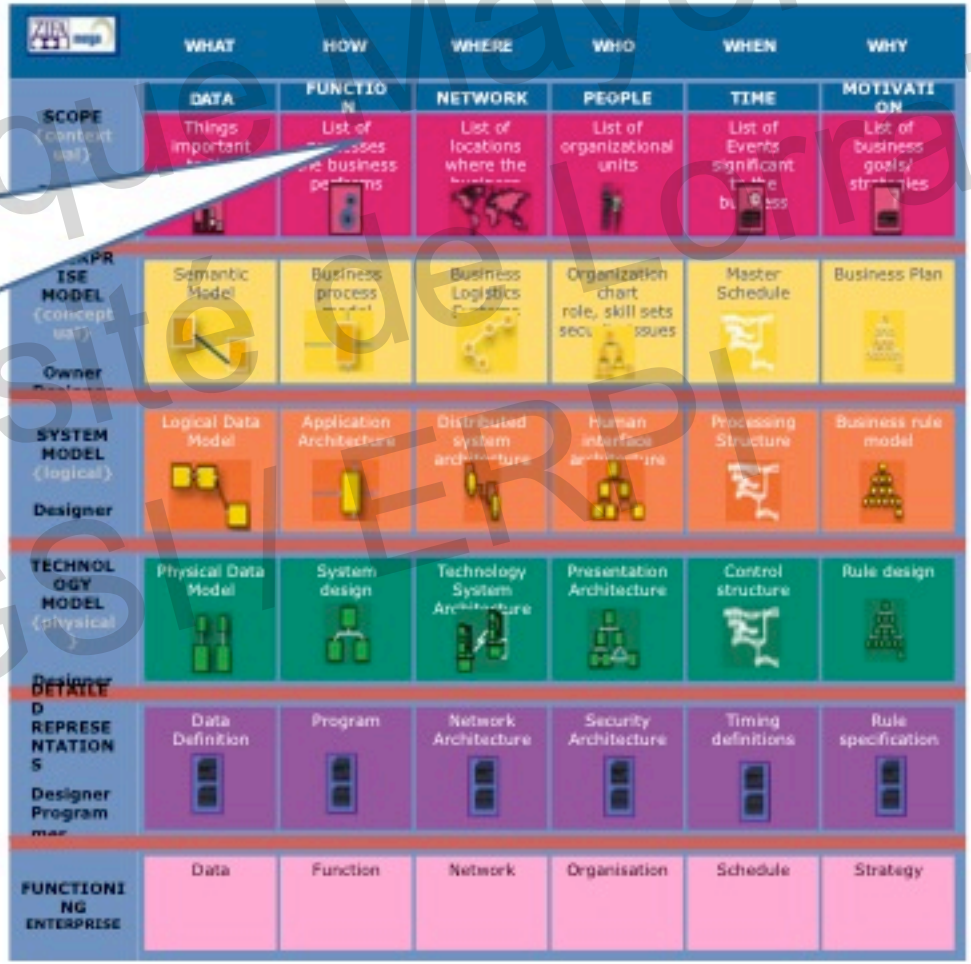
  - A MBSE approach typically includes methods for model management which aim to ensure that models are properly controlled and methods for model validation which aim to ensure that models accurately represent the systems being modeled.

MEGA Suite for Systems Engineering with MEGA tool.

Model Based Systems Engineering (MBSE) to model the reality of a System in order to right engineering!

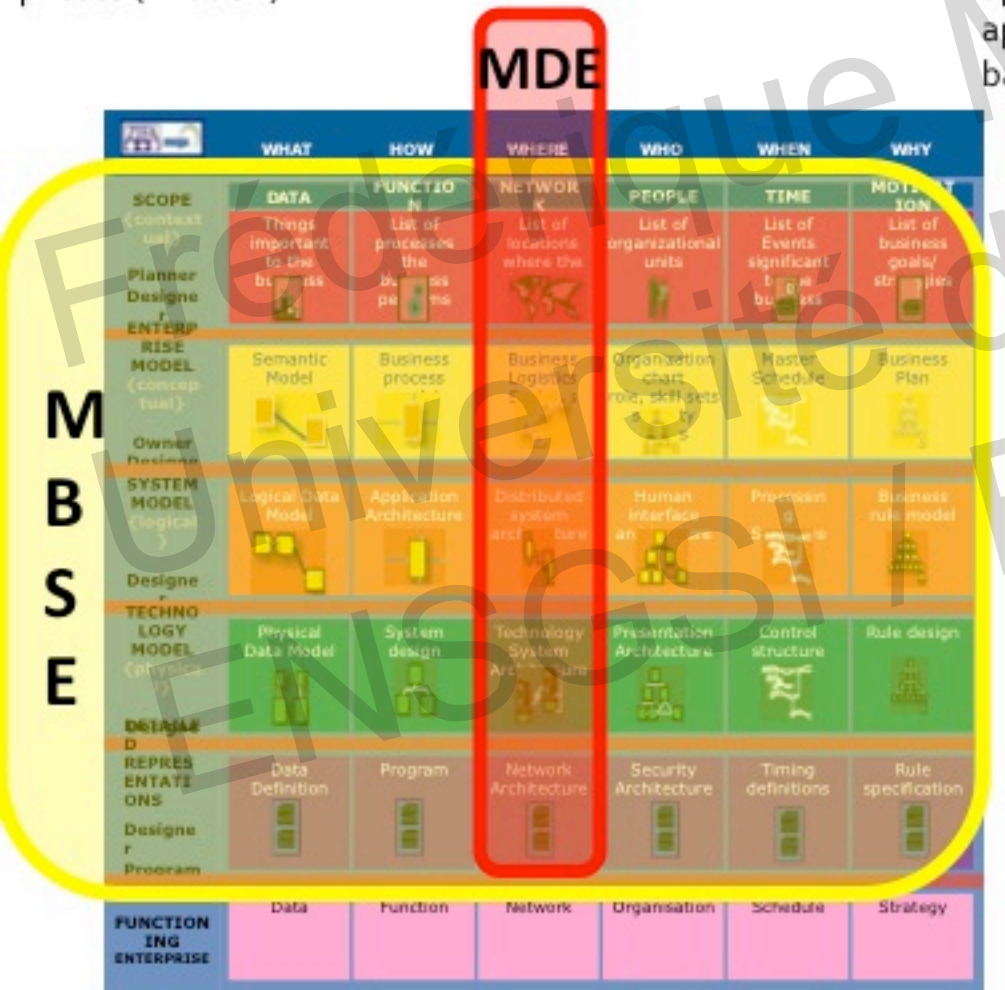
- Methods and Tools for model based systems engineering (MBSE)
  - A Systems Engineer can use an Analyze Table for MBSE.

Enterprise Information Systems Engineering ZACHMAN Modeling Framework.



Enterprise Information Systems Engineering : ZACHMAN Modeling Framework

• Model-Based Systems Engineering (MBSE) is the formalized application of modeling to support system requirements, design, analysis, verification and validation activities beginning in the conceptual design phase and continuing throughout development and later life cycle phases (INCOSE).



• The software development evolves towards a vision centered on models (Model Driven Engineering). This evolution requires some progress regarding tools supporting the transformations of models. Furthermore, it is required also an evolution in the use of models, in the appropriateness between the modeling languages and the applications, in the definition of the development process based on models. (CNRS IDM)

– A modeling paradigm for MDE is considered effective if its models make sense from the point of view of a user that is familiar with the domain, and if they can serve as a basis for implementing systems. The models are developed through extensive communication among product managers, designers, developers and users of the application domain. As the models approach completion, they enable the development of software and systems.

Enterprise Information Systems Engineering : ZACHMAN Modeling Framework

- ZACHMAN could be used as
  - An analysis table for MOA in order to identify important « things » about the studied system for mastering and maintening his knowledge facing MOE.
  - A modeling framework for MOA and MOE to develop a coherent vison centered on models of a system as a whole.

Motivation for ZACHMAN : an analysis table and modeling framework for MBSE

- The Zachman framework can successfully be used as a tool for defining project scope, for checking project completeness, and as a learning tool for enterprise architecture.
  - Project scope definition: Most projects do not need to cover all enterprise analysis dimensions. The Zachman framework helps business analysts and system architects organize their thoughts about architecture and guides them to narrow the scope of the modeling artifacts required to carry out their projects. It is then easier to tackle the "where to start" question and to define a methodology path tailored to the project needs. For instance, rows in the framework identify types of stakeholders and the associated detail of information they require. Detailed SQL data types are not the right modeling artifact if the objectives is to build a map of core business objects.
  - Checking project completeness: Another difficult question to answer is whether any significant element was left out of the project scope. The Zachman Framework ensures all appropriate aspects are addressed or used as a discussion support tool. For instance, geographical location issues might be crucial for the project and must be analyzed at all levels of the abstraction stack: business process, IT ystems, distributed objects.
  - A learning tool: As enterprise architects get more familiar with enterprise modeling, they discover the benefits of having multiple dimensions for enterprise projects and how methodology steps can used to move from one cell to another. Model driven approach can be better enforced within project and increase their success factors.

Enterprise Information Systems Engineering : ZACHMAN Modeling Framework

- Modeling Rules
  - Rule 1: The columns have no ordering. No one is more important than another but focusing on one may have significant practical implications.
  - Rule 2: Each column represents a unique model.
  - Rule 3: Each column is unique although they are interconnected.
  - Rule 4: Each row represents a unique perspective.
  - Rule 5: Therefore, each cell is unique (no item should show up in more than one cell).
  - Rule 6: Each row is a complete model from the row's perspective
  - Rule 7: The logic is recursive and generic.

The columns table analysis of ZACHMAN

- The columns in the Zachman framework represent different areas of interest for each perspective. The columns describe the dimensions of the systems definition and development effort.

WHAT	HOW	WHERE	WHO	WHEN	WHY

- WHAT (Data): Each of the rows in this column address understanding of and dealing with an enterprise's data. In this column, the objects of interest that concern the company and affect its direction and purpose.
- HOW (Function): The rows in the function column describe the process of translating the mission of the enterprise into successively more detailed definitions of its operations.
- WHERE (Network): This column is concerned with the geographical distribution of the enterprise's activities.
- WHO (People): The fourth column describes who is involved in the business and in the introduction of new technology.
- WHEN (Time): The fifth column describes the effects of time on the enterprise. It is difficult to describe or address this column in isolation from the others, especially column two.
- WHY (Motivation): this is concerned with the translation of business goals and strategies into specific ends and means. This can be expanded to include the entire set of constraints that apply to an enterprise's efforts.

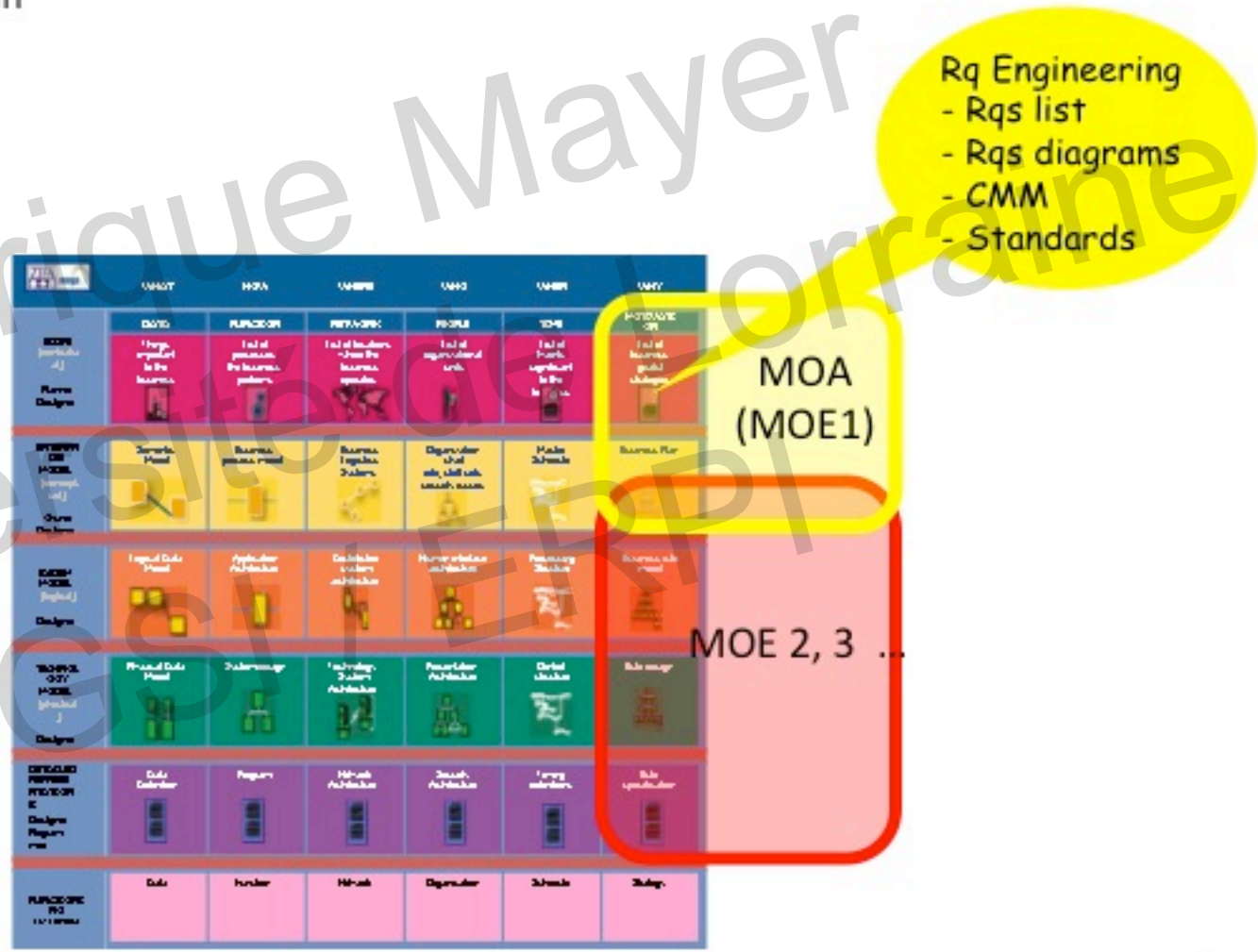
The rows table analysis of ZACHMAN

• The rows represent various abstraction levels typically involved in the systems definition and development process:

- Scope (Planer view): Definition of the enterprise's direction and business purpose. This is necessary to establish the context for any system development effort.
- Model of the business (Owner's view): This defines — in business terms — the nature of the business, including its structure, functions, organization, and so forth.
- Model of the information system (Architect's view): This defines the business described in step 2, but in more rigorous information terms.
- Technology model (Designer's view): This describes how technology may be used to address the information processing needs identified in the previous rows.
- Detailed representations (Builder's view): Here a particular language is chosen, and the program listings, database specifications, networks, and so forth are all produced.
- Functioning system: Finally, a system is implemented and made part of an organization.

Enterprise Information Systems Engineering : ZACHMAN Requirements Modeling

- Semantical relations of models of requirements engineering between MOA and MOE
  - WHY (Motivation) column



Enterprise Information Systems Engineering : ZACHMAN Requirements Modeling

• The columns in the Zachman framework represent different areas of interest for each perspective. The columns describe the dimensions of the systems definition and development effort.

• 6. WHY (Motivation): this is concerned with the translation of business goals and strategies into specific ends and means. This can be expanded to include the entire set of constraints that apply to an enterprise's efforts.

- 6x1 In row one, the enterprise identifies its goals and strategies in general, common language terms.
- 6x2 In row two, these are translated into the specific rules and constraints that apply to an enterprise's operation.
- 6x3 In row three, business rules may be expressed in terms of information that is and is not permitted to exist. This includes constraints on the creation of rows in a database as well as on the updating of specific values.
- 6x4 In row four, these business rules will be converted to program design elements,
- 6x5 In row five, they will become specific programs.
- 6x6 In row six, business rules are enforced.

Enterprise Information Systems Engineering : ZACHMAN Requirements Modeling

- Joint Methods and Tools for model based systems engineering (MBSE)
  - A Systems Engineer can use a combination of analysis table and modeling framework, methods and tools for MBSE with a System Thinking.
  - Semantical relations of models of requirements engineering between MOA and MOE

Enterprise Information Systems Engineering : ZACHMAN Requirements Modeling

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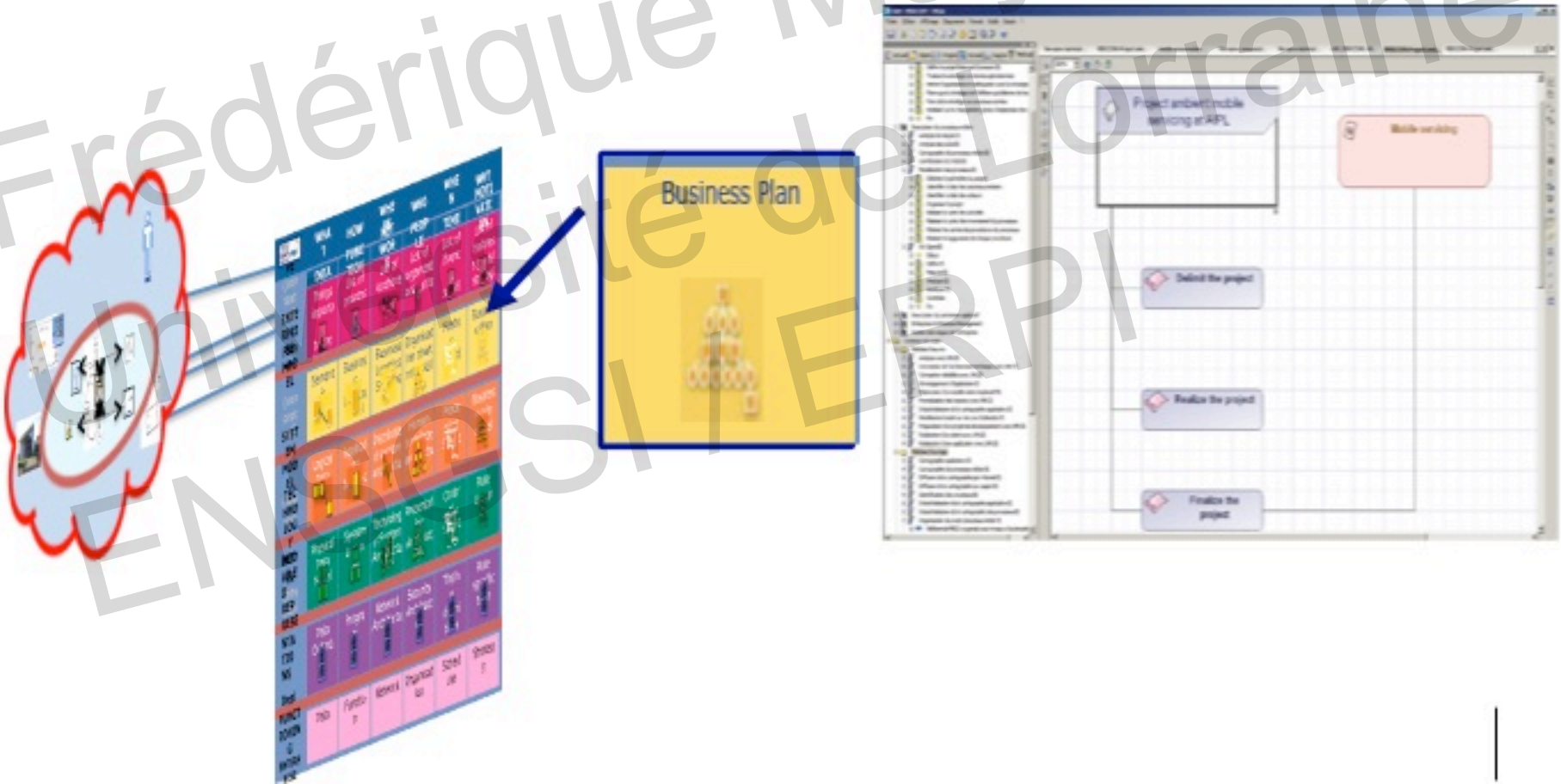

Enterprise Information Systems Engineering : ZACHMAN Requirements Modeling

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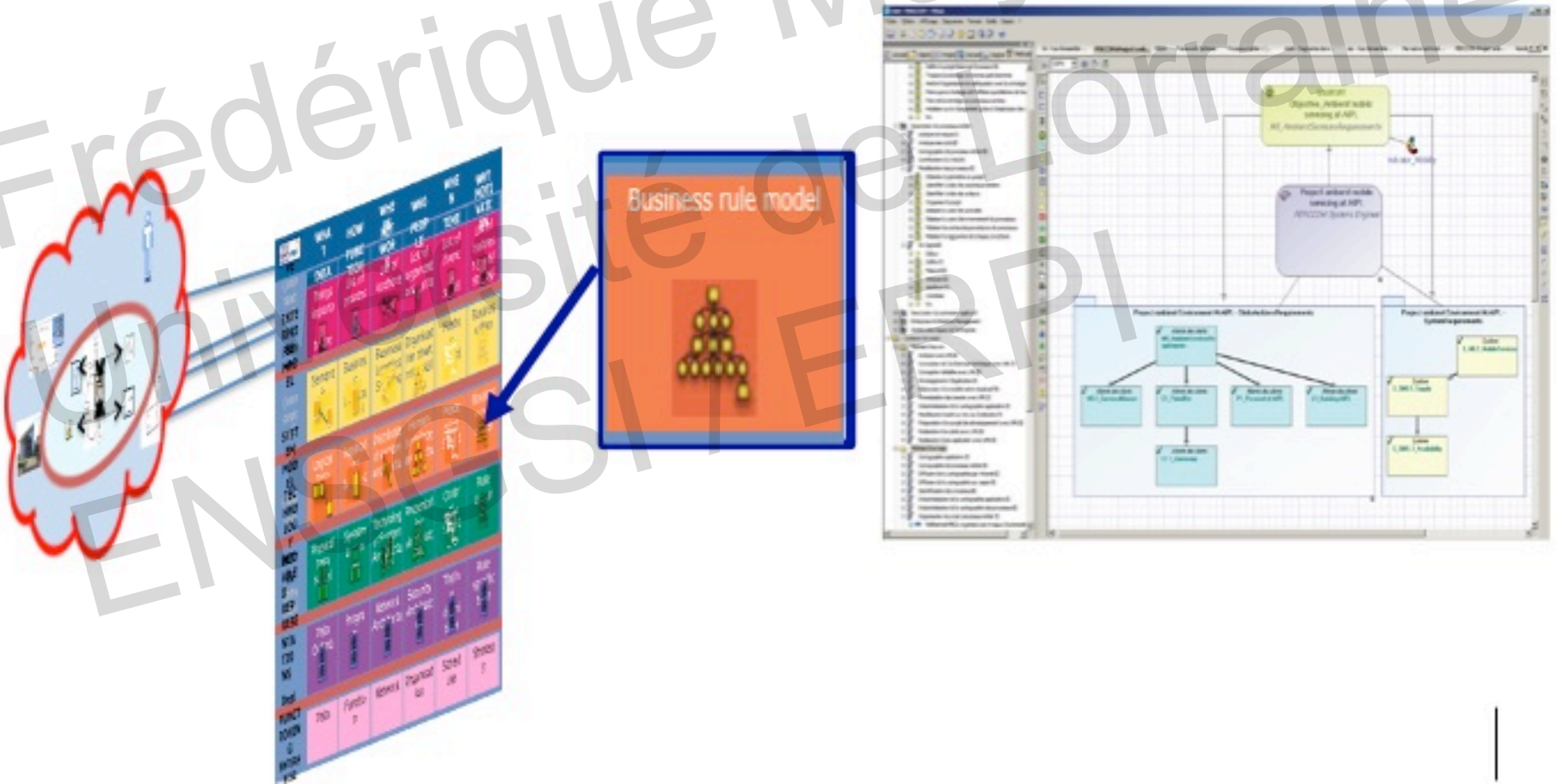


Enterprise Information Systems Engineering : ZACHMAN Requirements Modeling

- Joint Methods and Tools for model based systems engineering (MBSE)

Enterprise Information Systems Engineering : ZACHMAN Data Modeling

- Transformation of Data Models
  - WHAT (Data) column

-Objects of interest
- Semantic model
- Logical model
- Relational model
- Database schema

Enterprise Information Systems Engineering : ZACHMAN Data Modeling

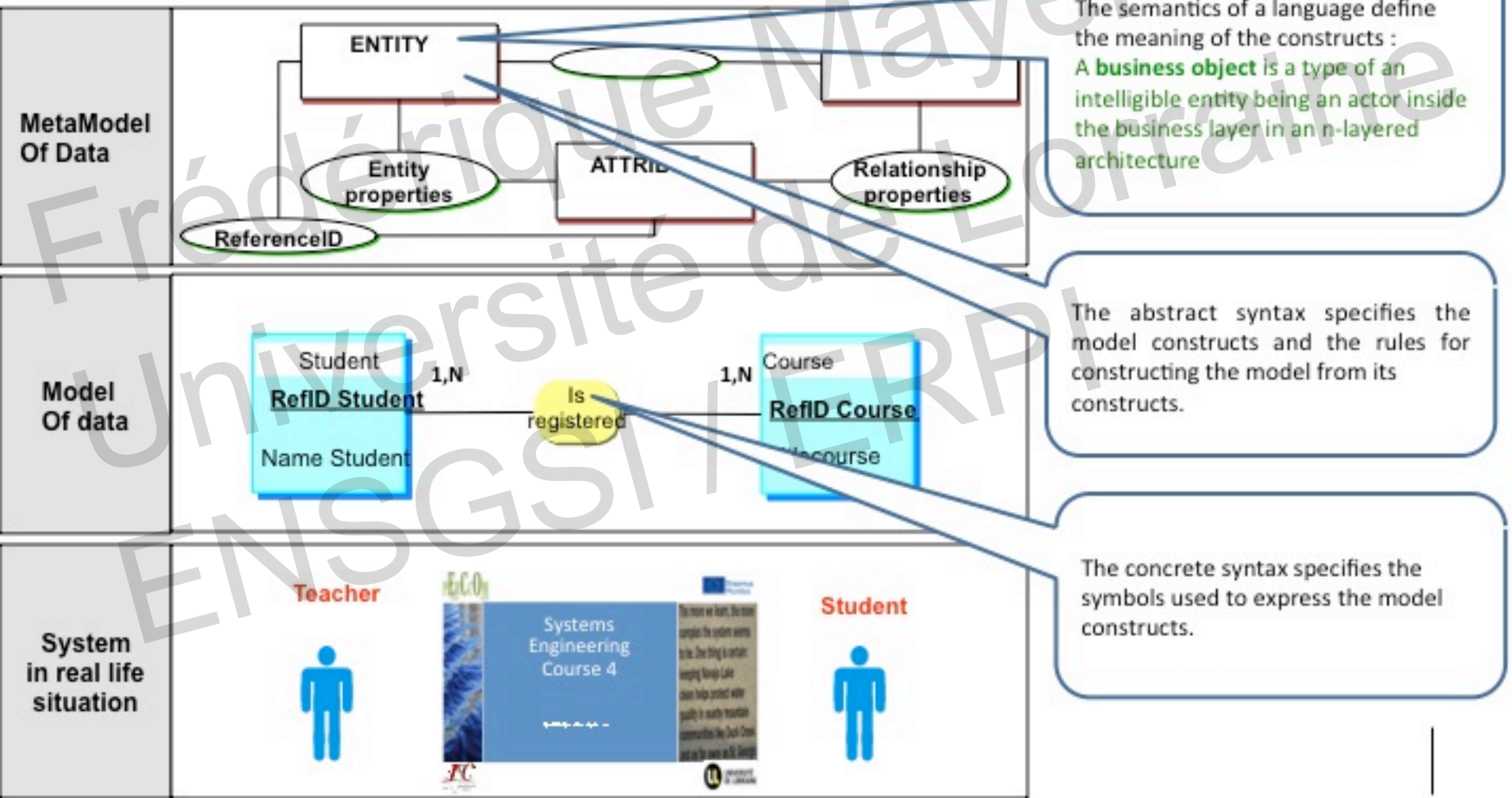
• The columns in the Zachman framework represent different areas of interest for each perspective. The columns describe the dimensions of the systems definition and development effort.

• 1. WHAT (Data): Each of the rows in this column address understanding of and dealing with an enterprise's data.

- 1x1 This begins in row one with a list of the things that concern the company and affect its direction and purpose.
- 1x2 Row two, is a contiguous model of the things seen by the participants in the business. Many-to-many and n-ary relationships may be present; reflecting the way the business views them. Also, relationships may be shown which themselves have attributes.
- 1x3 Row three provides more of an information-based perspective, resolving many -to-many and n-ary relationships, along with relationships containing their own attributes. Indeed, attributes are more exhaustively defined, and unique identifiers are specified. Entities are generalized to more closely reflect the underlying structure of the business and its relationships.
- 1x4 In row four, entities are converted to table definitions, object classes, hierarchy segments, or whatever is appropriate for the kind of data base management system to be used. This is tantamount to creating the data definition language statements.
- 1X5 In row five, the tables are actually implemented on physical disk drives, using the underlying organization of the database management system. This is where table spaces are defined, disk packs are allocated, and so forth.
- 1x6 For row six, the actual database itself is created and initial data are converted and loaded.

Enterprise Information Systems Engineering : ZACHMAN Data Modeling

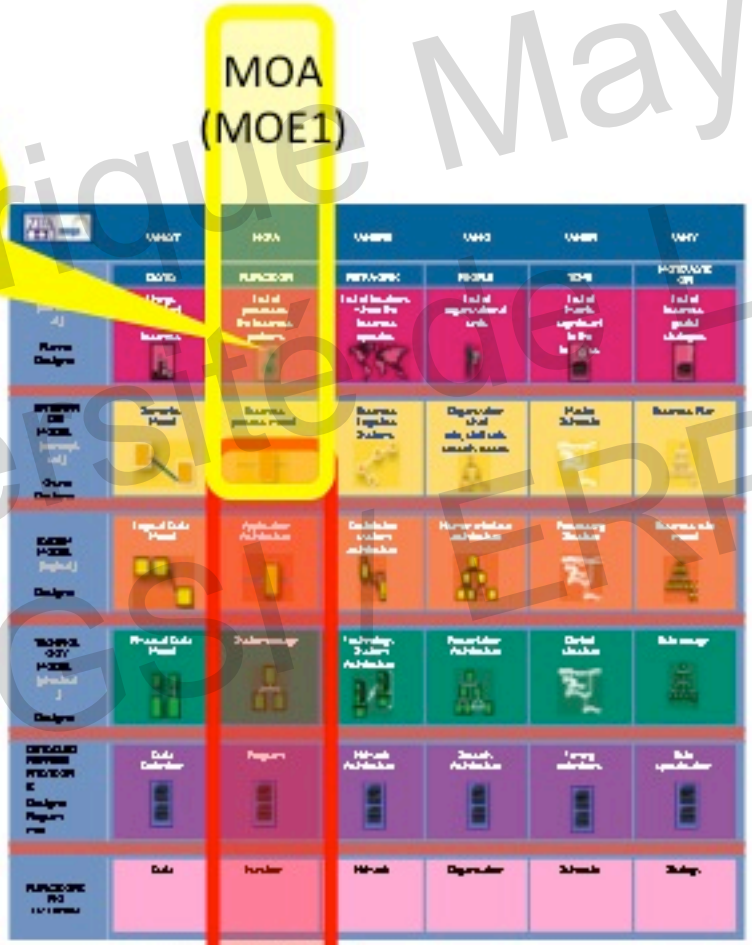
- MOTIVATION
  - In the context of systems engineering (in SEBoK), models rely on a modeling language to express their meaning.



Enterprise Information Systems Engineering : ZACHMAN Business Process Modeling

- Transformation of Business Models
  - HOW (Function) column

Semantic constructs
-Modalities
- Roles
- ...



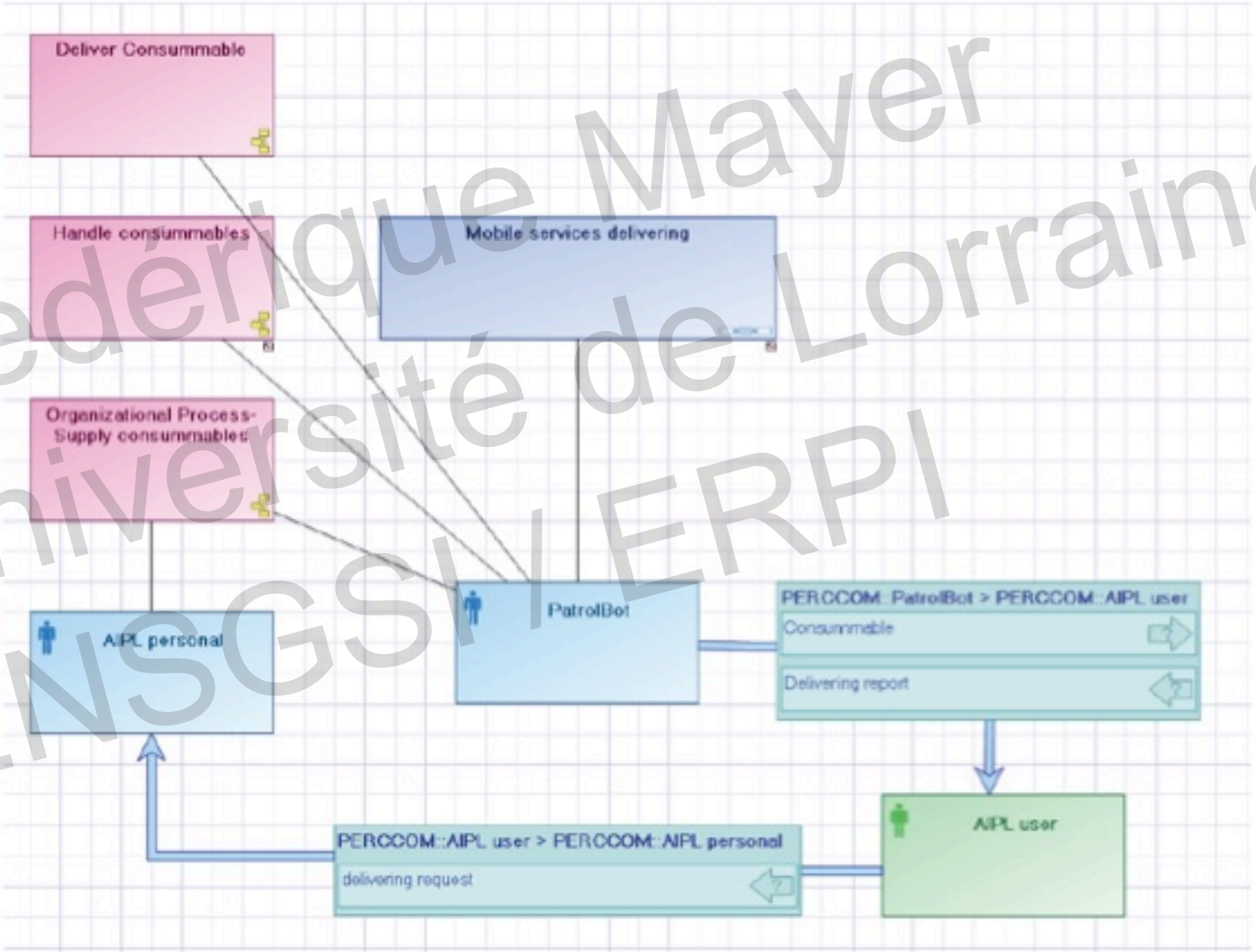
Enterprise Information Systems Engineering : ZACHMAN Business Process Modeling

• The columns in the Zachman framework represent different areas of interest for each perspective. The columns describe the dimensions of the systems definition and development effort.

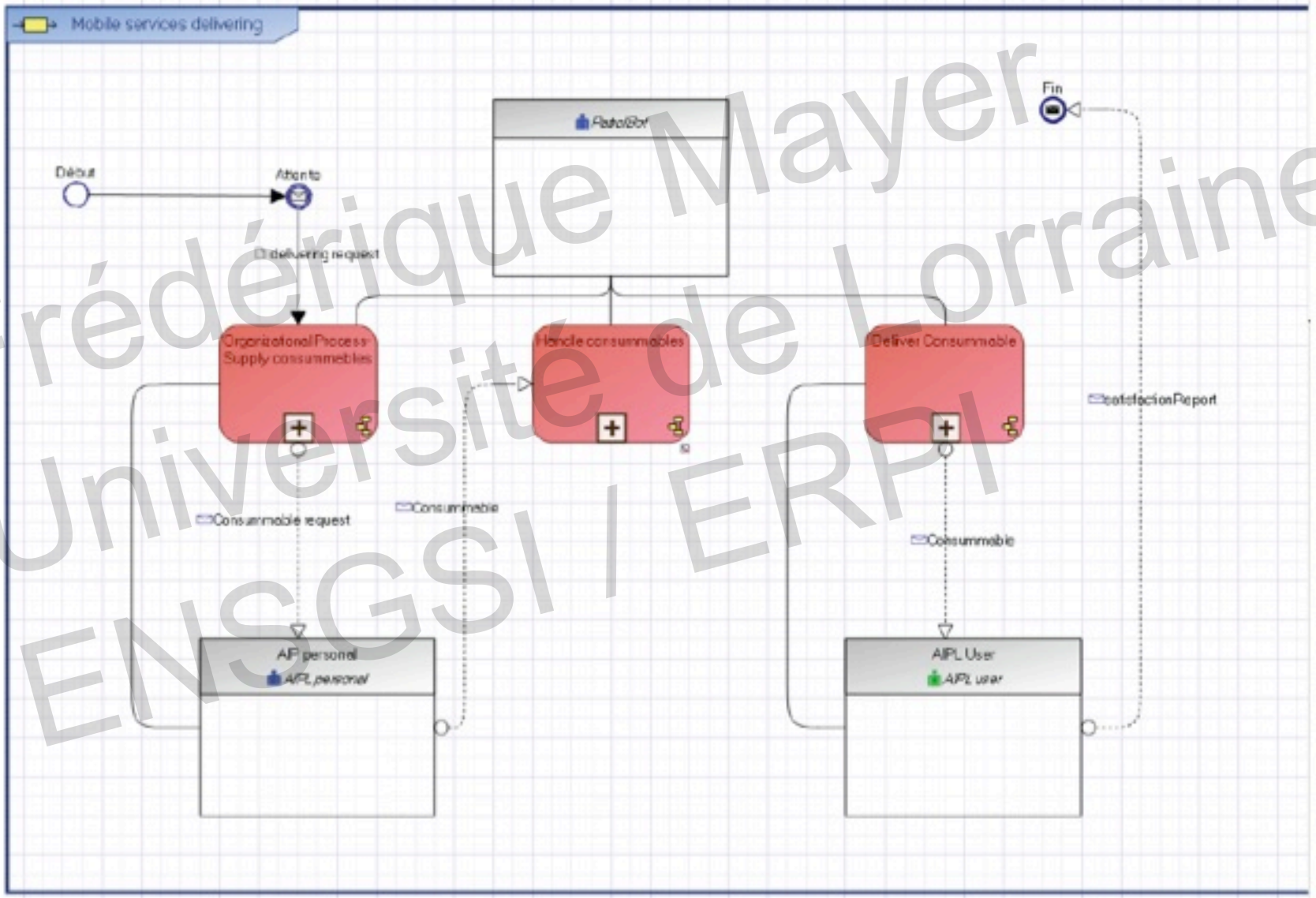
• 2. HOW (Function): The rows in the function column describe the process of translating the mission of the enterprise into successively more detailed definitions of its operations.

- 2x1 Row one is a list of the kinds of activities the enterprise conducts,
- 2x2 Row two describes these activities in a contiguous model.
- 2x3 Row three portrays them in terms of data transforming processes, described exclusively in terms of the conversion of input data into output data.
- 2x4 The technology model in row four then converts these data conversion processes into the definition of program modules and how they interact with each other. Pseudo-code is produced here.
- 2x5 Row five then converts these into source and object code.
- 2x6 Row six is where the code is linked and converted to executable programs. Note that in the object oriented approach, functions and data tend to be addressed together.

- HOW (Function) : 2x1 Row one is a list of the kinds of activities the enterprise conducts

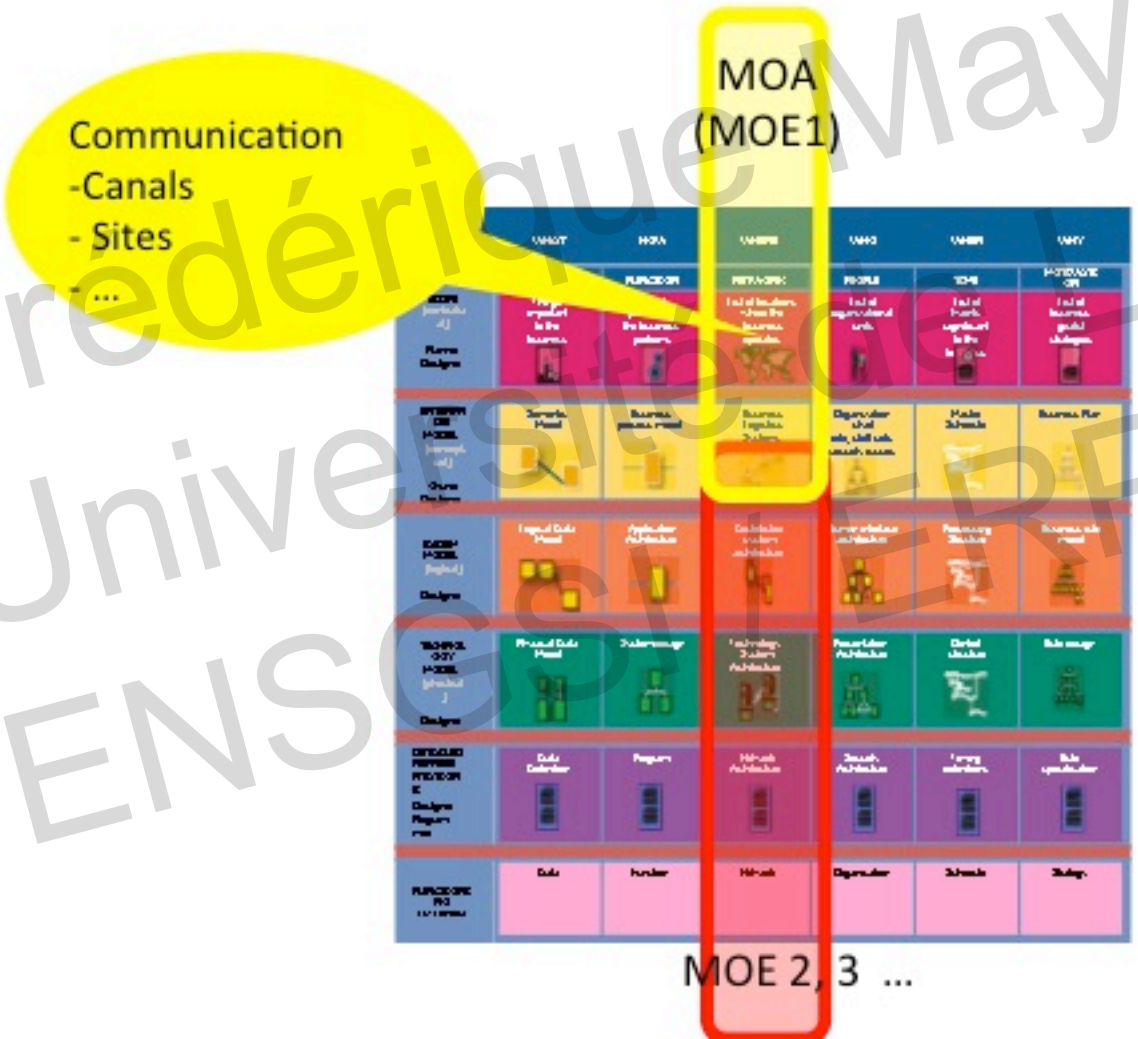


- HOW (Function) : 2x2 Row two describes these activities in a contiguous model.



Enterprise Information Systems Engineering : ZACHMAN Network Modeling

- Transformation of Communication Models
  - WHERE (Network) column



Enterprise Information Systems Engineering : ZACHMAN Network Modeling

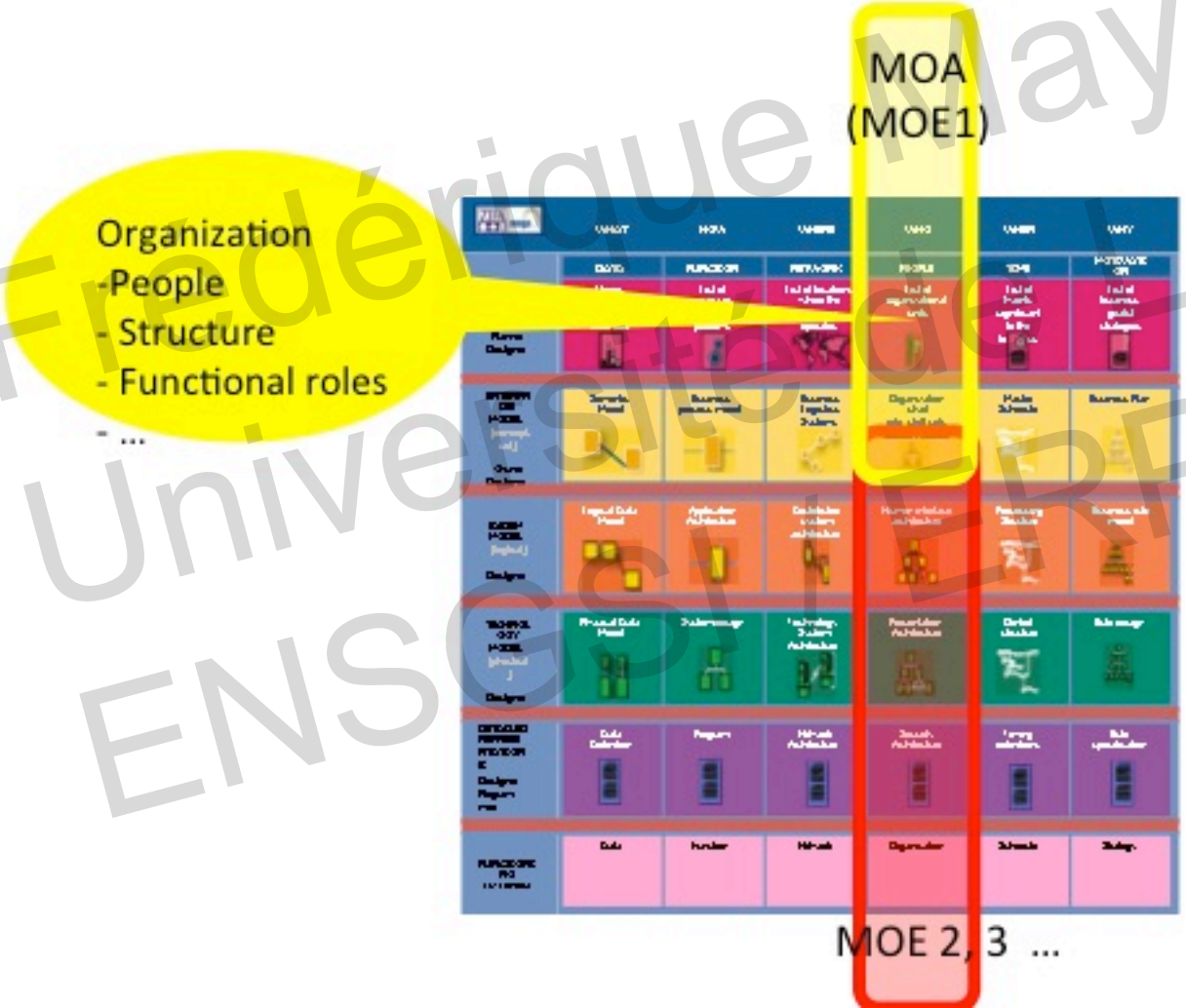
• The columns in the Zachman framework represent different areas of interest for each perspective. The columns describe the dimensions of the systems definition and development effort.

• 3. WHERE (Network): This column is concerned with the geographical distribution of the enterprise's activities.

- 3x1 At the strategic level (row one), this is simply a listing of the places where the enterprise does business.
- 3x2 At row two, this becomes a more detailed communications chart, describing how the various locations interact with each other.
- 3x3 Row three produces the architecture for data distribution, itemizing what information is created where and where it is to be used.
- 3x4 In row four, this distribution is translated into the kinds of computer facilities that are required in each location.
- 3x5 In row five, these facilities requirements are translated into specification of particular computers, protocols, communications facilities, and the like.
- 3x6 Row six describes the implemented communications facilities.

Enterprise Information Systems Engineering : ZACHMAN Organization Modeling

- Transformation of Organization Models
  - WHO (People) column



Enterprise Information Systems Engineering : ZACHMAN Organization Modeling

- The columns in the Zachman framework represent different areas of interest for each perspective. The columns describe the dimensions of the systems definition and development effort.

- 4. People: The fourth column describes who is involved in the business and in the introduction of new technology.
  - 4x1 The row one model of people is a simple list of the organizational units and each unit's mission.
  - 4x2 In row two, this list is fleshed out into a full organization chart, linked to the function column. Here also, requirements for security are described in general terms.
  - 4x3 In row three, the potential interaction between people and technology begins to be specified, specifically in terms of who needs what information to do his job. What roles do each play and what data are necessary for those roles? Along with this are specific definitions of security requirements, in terms of who (which role) is permitted access to what.
  - 4x4 In row four, the actual interface between each person and the technology is designed. In this row, issues of interface graphics, navigation paths, security rules and presentation style are addressed.
  - 4x5 In row five, this design is converted into the outward appearance of each program, as well as the definitions of access permissions in terms of specific tables and/or columns each user can have access to.
  - 4x6 In row six, you have trained people, using the new system.

Enterprise Information Systems Engineering : ZACHMAN Event-driven Modeling

- Transformation of Even-driven Models
  - WHEN (Time) column

Enterprise Information Systems Engineering : ZACHMAN Event-driven Modeling

• The columns in the Zachman framework represent different areas of interest for each perspective. The columns describe the dimensions of the systems definition and development effort.

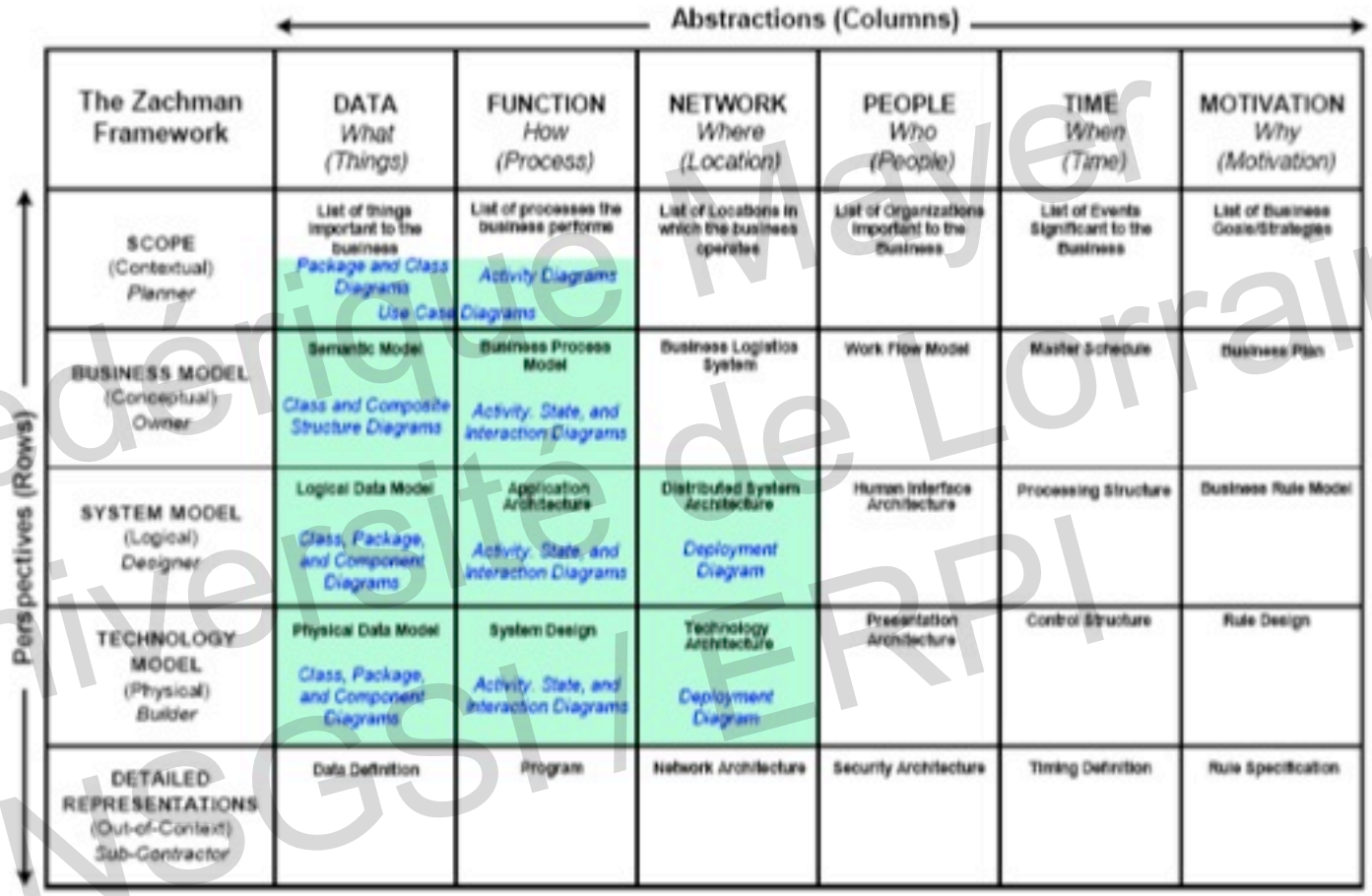
• 5. Time: The fifth column describes the effects of time on the enterprise. It is difficult to describe or address this column in isolation from the others, especially column two.

- 5x1 At the strategic (row one) level, this is a description of the business cycle and overall business events.
- 5x2 In the detailed model of the business (row two), the time column defines when functions are to happen and under what circumstances.
- 5x3 Row three defines the business events, which cause specific data transformations and entity state changes to take place.
- 5x4 In the technology model (row four), the events become program triggers and messages, and the information processing responses are designed in detail.
- 5x5 In row five, these designs become specific programs.
- 5x6 In row six, business events are correctly responded to by the system.

Enterprise Information Systems Engineering : MEGA ZACHMAN Portal

• MEGA Suite™ comes with an HTML service that acts as a Zachman Portal onto the repository. For each Zachman cell, a mapping window is provided that describes the concept used in MEGA, along with a query that selects the corresponding model objects in the current repository. Thereby, users can easily discover best modeling practices in MEGA with the standard guidelines provided by the Zachman Framework.

Enterprise Information Systems Engineering : Unified Modeling Language as candidate to support Zachman Modeling Framework



The Zachman Framework	DATA *What (Things)*	FUNCTION *How (Process)*	NETWORK *Where (Location)*	PEOPLE *Who (People)*	TIME *When (Time)*	MOTIVATION *Why (Motivation)*
SCOPE (Contextual) *Planner*	List of things important to the business *Package and Class Diagrams* *Use Case Diagrams*	List of processes the business performs *Activity Diagrams*	List of Locations in which the business operates	List of Organizations important to the Business	List of Events Significant to the Business	List of Business Goals/Strategies
BUSINESS MODEL (Conceptual) *Owner*	Semantic Model *Class and Composite Structure Diagrams*	Business Process Model *Activity, State, and Interaction Diagrams*	Business Logistics System	Work Flow Model	Master Schedule	Business Plan
SYSTEM MODEL (Logical) *Designer*	Logical Data Model *Class, Package, and Component Diagrams*	Application Architecture *Activity, State, and Interaction Diagrams*	Distributed System Architecture *Deployment Diagram*	Human Interface Architecture	Processing Structure	Business Rule Model
TECHNOLOGY MODEL (Physical) *Builder*	Physical Data Model *Class, Package, and Component Diagrams*	System Design *Activity, State, and Interaction Diagrams*	Technology Architecture *Deployment Diagram*	Presentation Architecture	Control Structure	Rule Design
DETAILED REPRESENTATIONS (Out-of-Context) *Sub-Contractor*	Data Definition	Program	Network Architecture	Security Architecture	Timing Definition	Rule Specification

Systems engineering to perceive the reality of a System in order to right engineering!

- At the beginning of the story, nothing shows you that the phenomenon in front of you … is a system. It is an unknown phenomena. But the story of this phenomenon is a story to be very simply told.

Solving objective : an ambient environment for AIPL that must be measured by an ambient indicator

Elicitation of Stakeholder requirement : Various consumables must be delivered to any requesting to perform ambient challenges for guarantying a safe working place for AIPL personal. An indicator measures this guarantee.

Refinement of Stakeholder requirement : The PatrolBot is a robot acquired by AIPL. PatrolBot must be used as the mobile services solution

PatrolBot

Adapted from PERCCOM Course 4, F. MAYER, 2013

A simple story of a System in General (you have) to understand : the Domain-of-Interest

- The Domain-of-Interest of the phenomenon is defined
  - The Domain-of-Interest is the space where the objects of the phenomenon will raise a question towards the actions of users and observers. Its follows from this question, an action for solving the problem.